CHAPTER 2

ADVANCED BASED FUNCTIONAL COMPONENTS

LEARNING OBJECTIVE: *Explain the basic functions of the Advanced Base Functional Component (ABC) System, as outlined in the NAVFAC P-437, and identify the basic operation of various types of advanced base field support facilities.*

The Seabees are involved in many projects, ranging from building playgrounds in local communities to renovating buildings or building structures from scratch; however, the primary responsibility of the Seabees must not be forgotten-the construction of advanced bases. It is the Seabee's job to get in the middle of a contingency situation and construct the temporary facilities required to support U.S. military operations.

When these services are called upon, Seabees are expected to react expediently, and planning time is often limited. Planning is still required to organize personnel working schedules, material requirements, and tool/equipment usage. At one time, this planning was not done in advance.

The need for advanced planning was discovered when our forces were jumping from island to island during World War II. It was realized that many of the requirements of the advanced bases were the same and a new advanced base could benefit from the planning done on a previous base. Advanced base requirements were grouped together into components according to their desired functions, and the ADVANCED BASE FUNCTIONAL COMPONENT (ABFC) SYSTEM was born. The ABFC System revolves around a building block type of system. The largest type of block is a COMPONENT, which brings together all of the people, facilities, equipment, and supplies required to perform a particular function. A component is made up of a FACILITY or a number of facilities that best meet your requirements. A facility is composed of smaller building blocks known as ASSEMBLIES. One or more assemblies are grouped together as required to make up the facility. A single assembly can often be used in several different facilities.

ABFC SYSTEM

LEARNING OBJECTIVE: *Explain the different sections of the ABFC Facilities Planning Guide, NAVFAC P-437. Identify setup, operation, and maintenance procedures for Utilitiesman—specific advanced base field assemblies.*

To bring together all of the information of the ABFC System, the Naval Facilities Engineering Command published the *Facilities Planning Guide,* NAVFAC P-437, volumes 1 and 2. Volume 1 contains all of the reproducible drawings and is divided into three parts. Part 1 has applicable plot plans for the components. Facility drawings are located in Part 2. The assembly drawings, which are used as the working drawings, make up Part 3. Each of the three parts is arranged in numerical/alphabetical sequence by component, facility, or assembly number. 'A picture may be worth a thousand words, but sometimes it takes a thousand and one words to convey an idea. To provide us with that "extra word," NAVFAC published volume 2. The written information concerning a component, a facility, or an assembly can be located by referring to this information-packed publication. Like volume 1, volume 2 is divided into three parts. Part 1 contains component information. The facility information is in Part 2. Part 3 contains the assembly information..

The advanced base support facilities discussed in this chapter will be the PORTABLE BATH UNIT; PORTABLE SPACE HEATER; IMMERSION HEATER; FIELD RANGE BURNER UNIT; CESSPOOLS, SEPTIC TANKS, TILE FIELDS, and LATRINES; LAUNDRY UNIT; AND WATER PURIFICATION UNITS.

By the use of various components, facilities, and assemblies, a construction battalion is able to construct advanced bases. Advanced bases include administrative, medical, living, messing, and other essential facilities. When the ABFC shipment arrives at the site, the assemblies and facilities should be distributed in the storage areas, so they are available in the order of erection or installation.

The first procedure is to check all parts against the bills of material. This action helps to ensure that all the parts have been included in the assemblies. Visually inspect all the components for damage. Check for dents, cracks, broken parts, and loose or kinked connections. If an item is missing or damaged, you should report the discrepancy to your supervisor, so steps can be taken to remedy the situation.

PORTABLE BATH UNIT

The nine-shower head Portable bath unit is a liquid fuel-fired water-heating device that supplies warm water to each of the shower nozzles. The bath unit is equipped with the necessary water heater, water pump assembly, mixing unit, hoses, and shower stands to supply all of the warm water needed for operation. The water pump draws water through the suction strainer and the hose from the water source and forces it through the discharge hose to the water heater. The water heater raises the temperature of the incoming water and maintains it at the desired temperature. The heated water is then forced through one discharge hose to the mixing unit where it is mixed with cold water to provide water at the desired temperature to the shower heads.

The electrical power required to operate the bath unit should be supplied by a self-contained portable 3 kW, 60 Hz, 208 V, three-phase power generator source. All of the components of the bath unit that are operated electrically should be grounded through a fifth wire incorporated in the power cables.

A description of major components to the portable bath unit is listed below. The location of each component is shown in figure 2-1

A. A SHOWER STAND ASSEMBLY. Eachofthe three shower-stand assemblies come equipped with three shower heads. Each shower head has a valve to control the water flow. A curtain is supplied to enclose each shower.

B. WATER HOSE ASSEMBLY. There are five 1-inch inside diameter (ID) hoses, each measuring 7 1/2 feet in length. The hoses interconnect with the water pump assembly, the water heater assembly, the mixing valve assembly, and three shower-stand assemblies

C. MIXING VALVE ASSEMBLY. The mixing valve assembly mixes hot water from the water heater and cold water from the water pump and water source to provide heated water to the shower stands at temperatures of approximately 105°F.

D. WATER HEATER. The water heater is a self-contained, liquified fuel-fired boiler that heats water supplied by the water pump. The major subassemblies or components that make up the water heater are the water vessel, the burner assembly, the blower assembly, the control box assembly, the sight glass assembly, and the transformer and ignition cables.

E. DRUM FILL ADAPTER ASSEMBLY. The drum fill adapter assembly can be used with either a 55 gallon fuel drum or a 5-gallon gasoline can. The fuel level can be checked visually and refueled without disconnecting the fuel lines.

F. FUEL CONTAINER. The fuel container may be either a 55-gallon fuel drum or a 5-gallon gasoline can.

G. FUEL FEED AND RETURN HOSE ASSEMBLIES. Flexible hoses provide supply and return fuel between the fuel storage container and the fuel pump assembly on the water heater.

H. POWER CABLE ASSEMBLY. The power cable assembly consists of two cables that extend from the Power source to the bath unit. The short cable connects to a 208 V, three-phase Power source. The long cable connects to the short cable, the water heater, and the water pump.

I. WATER PUMP HEATER-HOSE ASSEMBLY. The assembly consists of one 1 1/24nch ID hose, measuring 6 feet in length that connects the water pump to the water heater.

J. WATER PUMP. The water pump draws water from the source through the intake hose and the in-line strainer then supplies it through a discharge line to the water heater.

K. SUCTION HOSE ASSEMBLY. The suction hose assembly has one l-inch ID hose, measuring 25 feet in length that connects the water supply to the water pump.

L. SUCTION STRAINER ASSEMBLY. The suction strainer assembly is connected to the suction hose assembly. It prevents leaves and debris from entering the water system.

Setting Up the Bath Unit

Locate the bath unit so drainage from the shower area is carried downstream or downhill from the suction hose strainer to prevent wastewater from being

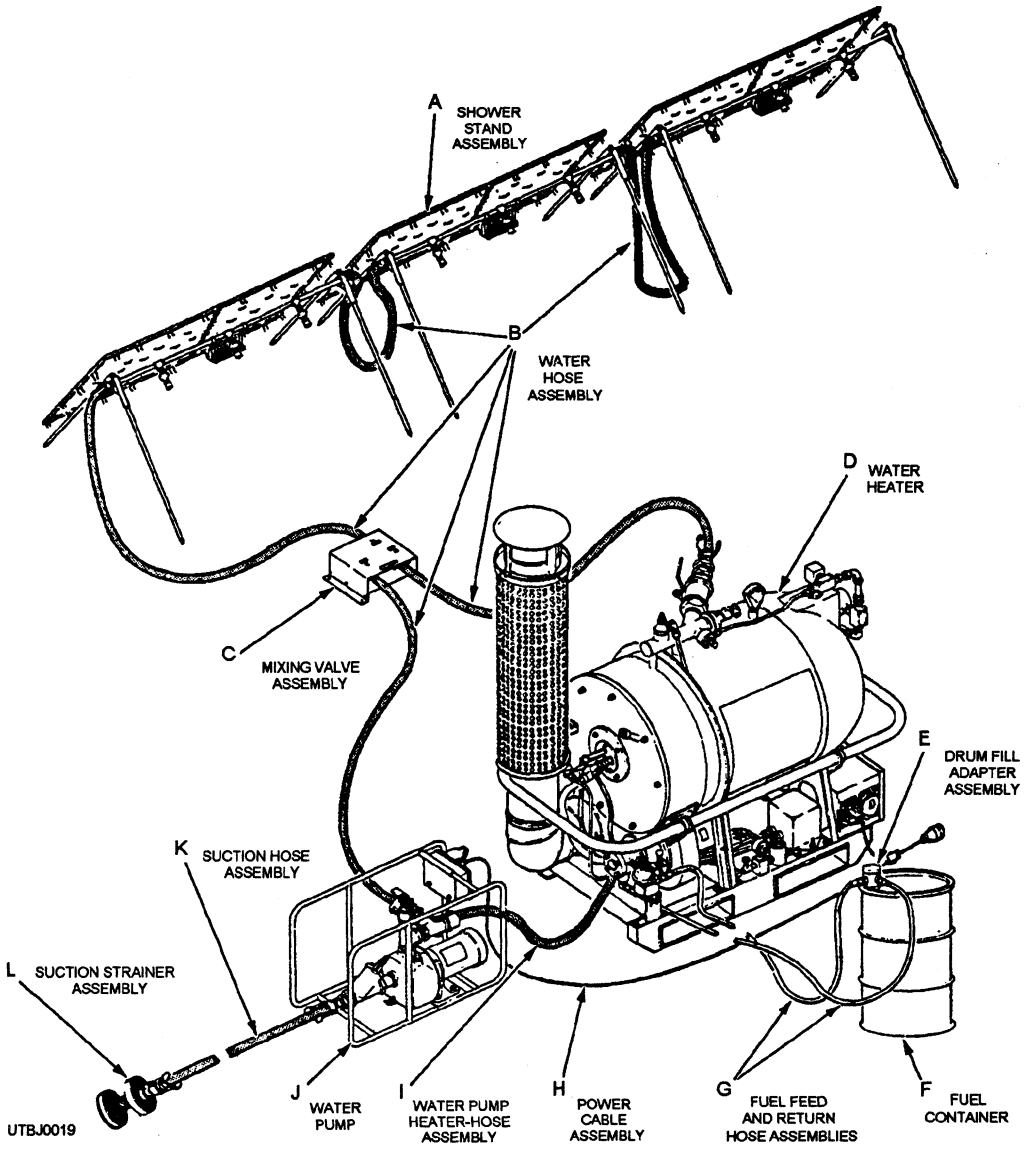


Figure 2-1.—Bath unit, portable, major components.

drawn back into the water source. If this arrangement is not possible, dig a ditch or build a dike around the shower stands to allow wastewater to drain away from the water source. When a pressurized water source is used, discharge the water into an open reservoir before it is drawninto the bath system. This prevents excessive strain on the water pump. Use the following procedures to set up the bath unit:

WARNING

Do not connect the heater to an untested water supply. Contaminated water can cause illness or death.

CAUTION

To prevent equipment damage, be sure the hose couplings are free of dirt or foreign matter and the coupling gaskets are in place before you couple the hoses.

1. Connect the section hose strainer to the male end of a 25-foot long, l-inch ID hose.

2. Connect the female end of the water hose to the water pump suction port.

3. Place the water pump on a level surface approximately 20 feet from the water source. Be sure the suction line does not exceed 5 feet in length.

4. Place the suction hose assembly and strainer into the water source using one of two methods:

a. Place the strainer on a mound of stones or gravel and make a large pile of stones upstream from the strainer to divert debris from it.

b. Build a tripod using tree branches and suspend the strainer from the tripod. Build a barrier using tree branches upstream from the strainer to prevent leaves, weeds, or other debris from entering the strainer.

5. Place the water heater on level ground approximately 5 feet from the water pump. When it is possible, arrange a suitable shelter or windbreak for the water heater to conserve fuel.

6. Connect the male coupling of a 1 1/2-inch water hose to the water pump and connect the female end of the hose to the water heater intake.

7. Connect the female end of a 7 1/2-foot, 1-inch ID hose to the water heater and the male end of the hose to the HOT fitting on the mixing valve.

8. Connect the male end of a 7 1/2-foot, 1-inch ID hose to the water pump outlet and the female end of the hose to the COLD fitting of the mixing valve.

9. Erect the shower stand approximately 20 feet from the mixing valve. Connect sections of the shower stand assembly using a 7 1/2-foot, 1-inch ID hose. Install the cap on the shower stand end connector.

10. Connect the female end of a 25-foot, 1-inch ID hose to the MIXED fitting of the mixing valve. Connect the male end of the hose to the female fitting of the shower stand.

11. Install an elbow on the water heater with a slight turn to the right to seat the pin in the slot.

12. Insert a smokestack and guard assembly through the bracket onto the elbow.

13. Tighten the screw on the bracket to secure the smokestack and guard assembly.

14. Place the fuel container approximately 5 feet from the water heater.

WARNING

The fuel used with the bath unit is highly flammable and may be dangerous to human life if handled improperly. Tighten all fuel fittings firmly. Recheck all fittings when the water heater is operating to ensure there are no leaks with the system under pressure.

15. Screw the drum fill adapter into the fuel container.

16. Connect the fuel line from the pump filter to suction the fitting on the drum fill adapter assembly.

17. Connect the fuel line from the pump to the return fitting.

18. Connect the cable assembly to the water heater, the water pump, and the power source.

WARNING

Use only the fuel specified. Failure to do so may result in injury to personnel or equipment.

CAUTION

The lack of lubrication may cause pump damage when pure gasoline is used as fuel. To avoid failure, when Firing the fuel burner with gasoline, mix 1 quart of oil with each 5 gallons of gasoline. This mixture provides internal lubrication for the fuel pump. To ensure proper mixture, pour the gasoline into the oil.

19. Fill the fuel container with the approved fuel mixture.

Preventive Maintenance Checks and Services (PMCS)

To ensure that the equipment is ready for operation at all times, you must inspect it systematically before operation, during operation, and after operation, so defects may be discovered and corrected. The necessary preventive maintenance checks and services (PMCS) will be performed before operation. The

defects discovered during operation of the unit will be noted, and corrections made as soon as operation has ceased. Stop the operation immediately if a deficiency is noted that could damage the equipment. After operation, the necessary PMCS must be performed. Report defects or unsatisfactory operating characteristics beyond your scope to your supervisor.

The PMCS procedures are contained in the operating manual provided with the field unit.

Preparation for Use

Before you start the bath unit, go to the "Operator's Preventive Maintenance Checks and Services (PMCS)" and do the "Before Operation" checks and then proceed as follows:

- Make certain the water heater load limit switch is turned to OFF.
- Make sure the manual fuel valve is closed.
- Press the reset button to ensure the flame safeguard control is not locked out.
- Open the blower shutter approximately halfway.
- Open the fuel pump primer plug and fill the fuel container with the fuel mixture. Replace the plug.

Make sure that one end of the hose is connected to the supply fitting of the fuel filter and to the fittings on the vent. Connect the return fuel line to the drum fill adapter.

NOTE

The operator must periodically monitor the level of the fuel supply. The fuel container should be kept as full as possible to reduce water condensation. The frequency of refueling depends on the size of the fuel container. Excessive water in the fuel supply decreases heater efficiency and corrodes both chamber and the burner.

WARNING

Exposed fuel and fuel vapor can ignite or explode, resulting in possible serious injury and even death. Observe proper safety precautions when servicing the fuel system. Ensure the water heater is cold before servicing the burner.

- Check to see that all water lines are connected.
- Be certain the water heater drain cock is closed.
- Check to be sure the smoke-pipe elbow, the two lengths of the smoke-pipe guard assembly, and the smoke pipe are securely installed.

Start-up Procedures

After having performed the recommended PMCS and the water heater is ready for use, you should proceed as follows:

- Turn off the limit switch and connect the power cable to the power source. Close the fuel valve by turning it to the right.
- Remove the plug and fill the coupling with water.
- Replace the plug.
- Open the fuel valve and turn the load limit switch and power source ON. The fuel pressure gauge should indicate 100 psi.
- View the ignition spark through the sight tube after the power is turned ON.
- Wait 7 seconds; then view the combustion through the sight tube.
- If combustion does not occur after an additional 12-second wait, the buzzer sounds and the ignition spark shuts down. Wait 2 minutes after the buzzer sounds and press the safety reset button. If combustion still does not occur, troubleshoot the unit according to table 2-1.
- After start-up, the exhaust gases from the exhaust stack should be transparent and smokeless. When smoke is present, open the air band on the blower assembly slowly until the exhaust gases are transparent and smokeless. The water heater is now in automatic operation.

Shutdown Procedures

Perform the following shutdown procedures after normal use or when the equipment will not be used for an extended period:

- Turn off the fuel valve.
- Turn off the load limit switch.
- Turn off the water pump.

If there is danger of the bath unit freezing, perform the following procedures:

Table 2-1.—Troubleshooting Procedures

Component	Malfunction	Corrective Check
Water Heater	Fails to start	1. Electrical power source 2. Load limit switch 3. Flame safeguard control 4. Blower motor reset 5. Water supply in tank 6. Low-water probe 7. Low-water relay
Burner	Flame failure during fire cycle	1. Fuel supply 2. Fuel hoses 3. Fuel nozzle 4. UV scanner 5. Flame safeguard control 6. Fuel pump strainer 7. Fuel pump drive coupling 8. Fuel pump 9. Fuel solenoid valve
Burner	Fails to ignite or is delayed	1. Fuel supply 2. Fuel hoses 3. Burner nozzle 4. Water in fuel 5. Electrodes 6. Ignition transformer 7. Burner to transformer connection
Fuel Pressure Gauge	Pressure too high	1. Fuel Gauge 2. Fuel Pump 3. Fuel nozzle 4. Fuel hose (return)
Fuel Pressure Gauge	Pulsating pressure	1. Suction hose 2. Fuel pump strainer 3. Fuel filter 4. Burner nozzle 5. Pressure Gauge
Fuel Pump	Noisy	1. Suction hose 2. Fuel pump strainer 3. Fuel filter 4. Fuel pump
Fuel Pump	Leaks	1. Strainer cover 2. Plugs 3. Shaft seals 4. Fuel pump for cracks

Table 2-1.—Troubleshooting Procedures—Continued

Fuel Pump	Fails to deliver fuel to burner	1. Fuel supply 2. Reversed pump rotation 3. Suction/discharge fuel hoses 4. Fuel pump strainer 5. Burner nozzle 7. Pump drive coupling 8. Fuel solenoid valve
Blower Motor	Continues to trip off	1. Fuel pump and motor
Smokestack	Gases are smoky	1. Electrode spark 2. Contaminated fuel 3. Burner nozzle 4. Blower operation 5. Power source - low- voltage output
Smokebox Cover	Escaping smoke	1. Boiler box gasket 2. Smokebox cover bolts
Water Temperature Gauge	Indicates overheating	1. Temperature control 2. Low-water probe
Water Pump	Fails to deliver water	1. Pump motor 2. Shaft seals
Shower Stand Nozzles	Not discharging enough water	1. Water flow control valves 2. Fittings

- Open the drain cock on the water pump by turning it to the left and tilt the water pump on end to let the water drain out.
- Reach under the water heater and open the drain cock by turning it to the left.

When the bath unit is not scheduled for use for 5 days or more, perform the following procedures:

- Remove the fuel feed hose from the fuel container.
- Place the end of the hose into a quart container.
- Fill the container with diesel fuel.
- Turn on the load limit switch and allow the unit to operate until the quart container is almost empty. Turn off the water heater fuel shutoff valve and let the system operate until the flame is extinguished.
- Turn off the load limit switch.

Troubleshooting Procedures

This section contains troubleshooting information for locating and correcting most of the operating troubles that may develop in your bath unit. The troubleshooting procedures are listed in table 2-1. The table lists the common malfunctions that you may find during operation or maintenance of the bath unit or its components. You should perform the tests/inspections and corrective actions in the order listed. Each malfunction for an individual component, unit, or system is followed by a list of tests or inspections to help you determine what corrective action(s) to take. This manual does not attempt to list all possible malfunctions and corrective actions or all the necessary tests and inspections. Remember, you should always notify your supervisor when something unusual occurs.

PORTABLE SPACE HEATER

Types I and II portable space heaters are designed to heat tents. The heater assembly consists of essentially a heater body (top and bottom), adapter ring, grate or liquid fuel burner assembly, and air conditioning-heating pipe sections. (See figs. 2-2 and 2-3.)

Type I heaters may be operated with wood or coal. Type II heaters operate with diesel oil, light fuel oil, or gasoline. The heat output is measured in British thermal units (Btu). The fuel consumption rates are as follows:

Type I (coal) 1/4 ton per week

Heat output (normal) 35,000 Btu per hour (maximum) 45,000 Btu per hour

Type II (gasoline or oil) 5 gallons for 10 to 30 hours

Before you place the heater in service, perform the following procedures:

- Inspect the entire heater assembly for signs of physical damage.
- Inspect the heater to be sure it is assembled properly, secure, clean, adjusted correctly, and mechanically operable.
- Correct deficiencies within the scope of organizational maintenance before placing the heater in service.
- Perform daily preventive maintenance services.

Setting Up the Heater

Place the heater base on the ground or floor of the tent. In tents with wooden floors, the base should be set in a sandbox or on sheeting that is designed to protect the floor from heat. In an emergency, a pile of stones or brickbats may be used. The sandbox must meet the following standards:

1. It must be no smaller than 40 inches long by 28 inches wide by 4 inches high. Use 2- by 4-inch lumber for the framework.

2. It must have a sheet metal bottom to act as an insulating shield.

3. The stove should be placed in the center of the box with a minimum of 3 1/2 inches of sand between the bottom of the stove and the metal insulation shield.

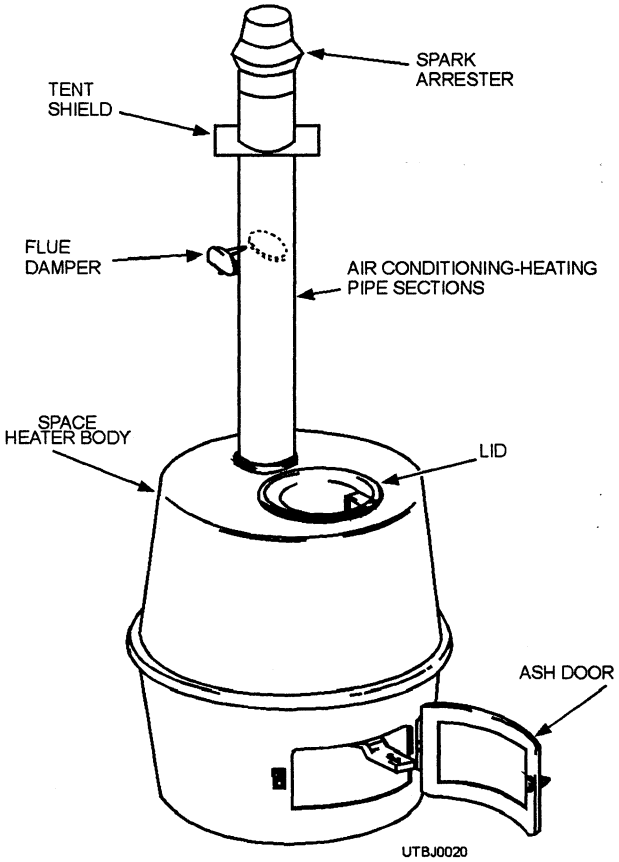


Figure 2-2.—Space heater (Type I).

4. Areas surrounding the stove should be void of combustibles at any point closer than 4 feet on a horizontal plane from the floor to the ceiling of the tent or building. Necessary material may be secured locally upon approval of the local commander.

To assemble and set up the Type I space heater components, refer to figure 2-4 and proceed as follows:

1. Assemble the grate.

2. Place the adapter ring on top of the base. Level the heater base by sight.

3. Insert the grate assembly in the adapter ring with the shaker catch facing the ash door and the draw grate on the bottom.

4. Place the top of the space heater on the adapter ring.

5. Assemble the air-conditioning smoke pipe as follows:

a. Join the formed edges of a curved sheet of metal to form a cylindrical pipe.

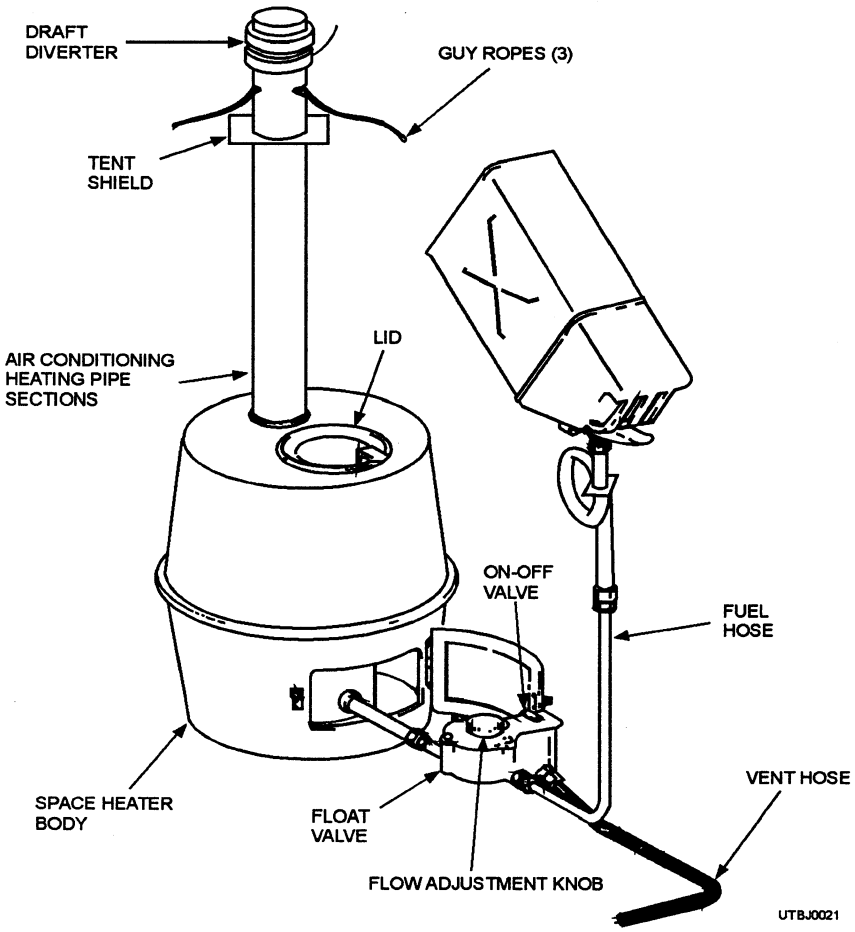


Figure 2-3.—Spate heater (Type II).

CAUTION

Hold the sheet metal securely while curling it to prevent it from slipping and causing severe cuts.

b. From the inside, insert a split rivet through each of the three holes in the smoke-pipe sections. Spread the tines of the rivet, and hammer them flat.

NOTE

The damper is not required in the smoke pipe when it is burning liquid fuel.

c. In one section of the smoke pipe, insert the damper. Punch a hole through the pipe at a position half the length of the pipe. Hold the damper in place inside the pipe, and thread the damper shaft through the holes locking the curved shank of the damper shaft into the center slot of the damper. When they are locked together properly, the damper and operating handle are parallel.

6. Assemble the smoke-pipe sections starting with the section of pipe having the damper installed. Place the smooth female end of the pipe over the steel collar on the heater top.

NOTE

When conditions permit, use six lengths of pipe extended straight up. Elbows and horizontal pipes reduce the draft and cut down the heat output.

7. Install the spark arrester on one pipe section above the heater or on top of the smoke pipe outside of the shelter.

To assemble and set up the Type II space heater, refer to figure 2-5 and proceed as follows:

1. Place the adapter ring on the heater base.

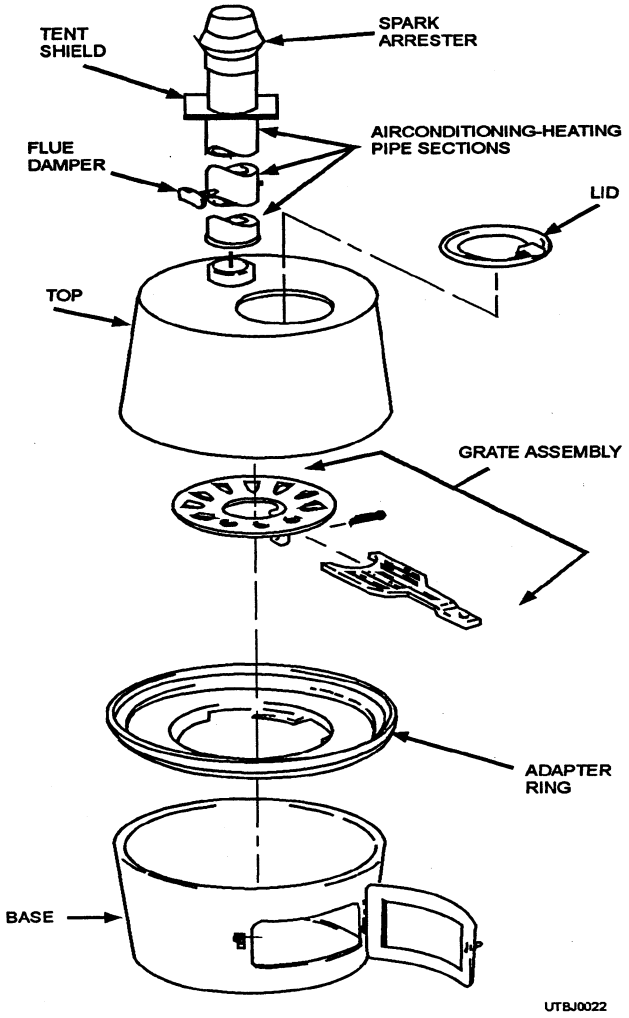


Figure 2-4.—Spare heater installation (Type I).

2. Set the oil-pot burner in the adapter ring, so the fuel inlet pipe faces the ash door opening.

3. Turn the adapter ring to the right until it engages the locking clips on the right side of the door opening.

4. Install the flame spreader in the center of the burner.

5. Attach the float valve nipple to the smaller end of the pipe reducer located on the oil-pot burner. Make sure the connection is tight enough to hold the valve in a level position and to prevent leaks.

6. Place the top of the space heater on the adapter ring.

7. Assemble the smoke pipe.

8. Install the draft diverter on top of the stack and anchor it with guy ropes.

CAUTION

Install the guy line radially to eliminate contact with the smoke pipe. Lines should be erected and anchored, so the movement of the tent does not adversely affect the stability of the smoke pipe.

Refer to figure 2-6, and assemble the fuel can adapter and insert it in the fuel can as follows:

CAUTION

When changing fuel cans, release the cam before removing the adapter from the empty can. The washer on the adapter may squeeze out of place when the adapter is screwed into place on the fuel can. Wipe excess fuel from the washer, the washer seat, and the lid of the fuel can.

1. Attach the male end of one fuel hose to the drip loop hose of the adapter, and attach the opposite female. end of the hose to the male fuel inlet fitting of the float valve.

2. Attach the other length of hose to the ovefflow fitting (under the center of the float valve) to carry off any possible overflow. This hose must drain downward and discharge into a safe outside location.

CAUTION

Be sure the fuel from the fuel can is connected to the male fitting marked “INLET” on the valve.

3. Make sure the inlet shutoff knob on the float valve is in the OFF position.

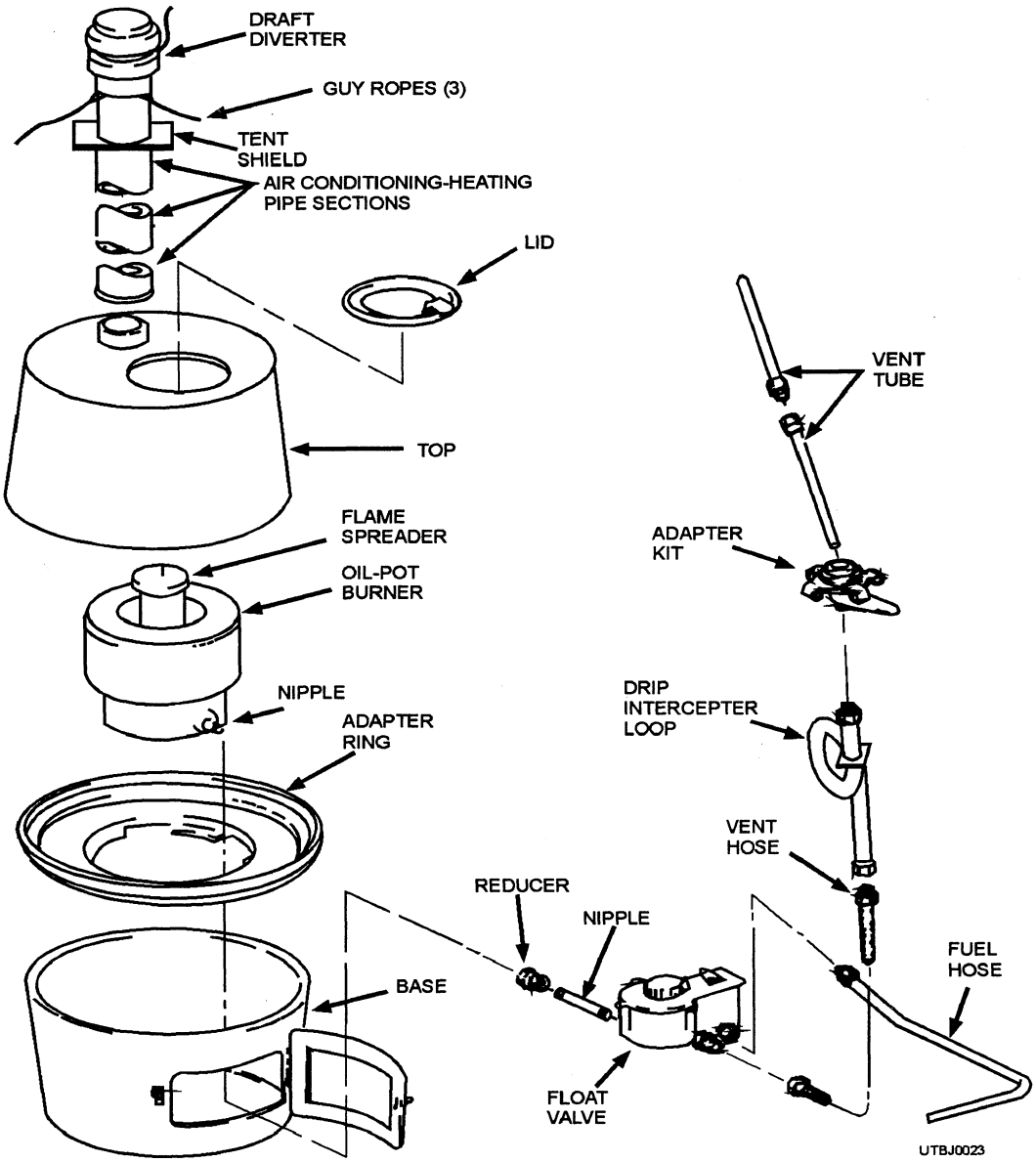


Figure 2-5.—Space heater installation (Type II).

4. Invert the fuel can on a support no less than 1 foot or more than 8 feet above the float valve.

Preventive Maintenance and Troubleshooting

To ensure the space heater is ready for operation at all times, you must inspect it systematically, so the defects may be discovered and corrected before they result in serious damage or failure. The preventive maintenance checks and troubleshooting procedures are listed in *Department of the Army Technical Manual,* TM 10-4500-200-13.

IMMERSION HEATER

The 32-gallon, immersion, liquid fired, water heater used by the Naval Construction Force (NCF) is shown in figure 2-7. The heater body is constructed of watertight sheet steel. The combustion chamber is doughnut-shaped, and the stack assembly is welded together. A vertical partition divides the stack into two sections: a burner compartment and a flue

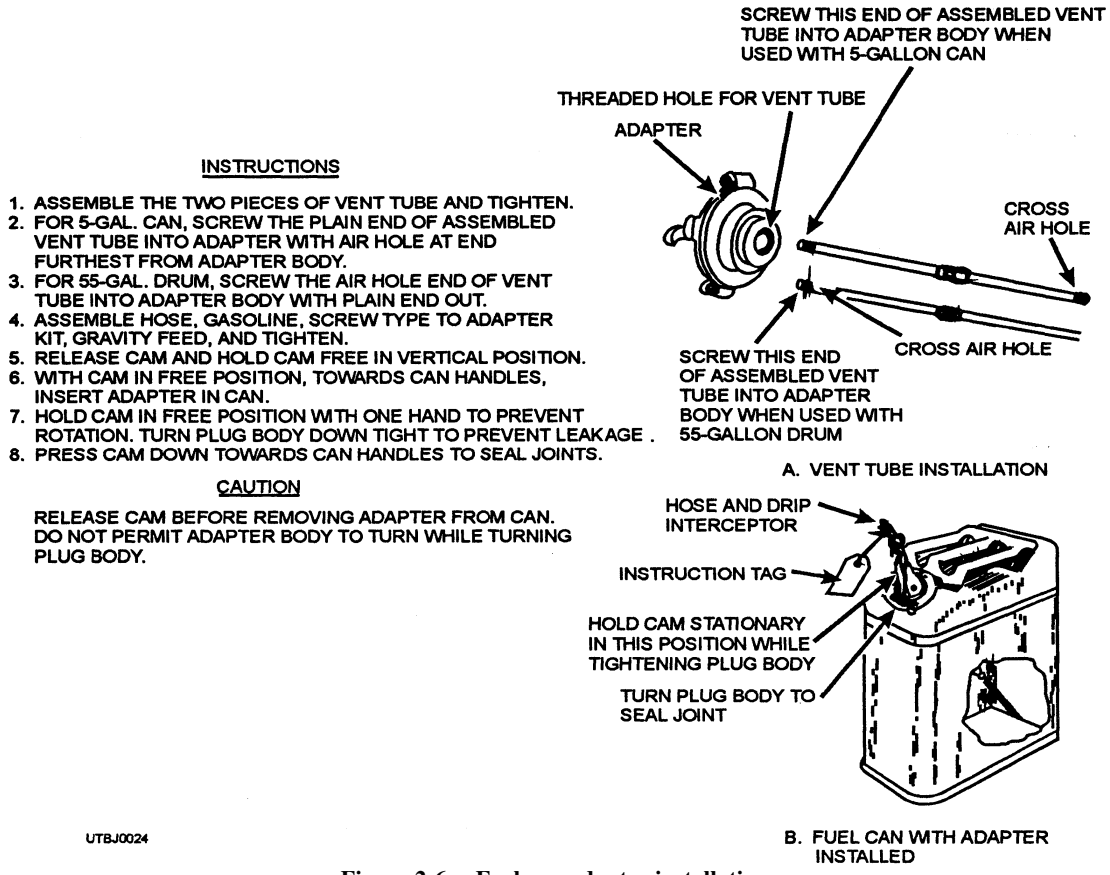


Figure 2-6.—Fuel can adapter installation.

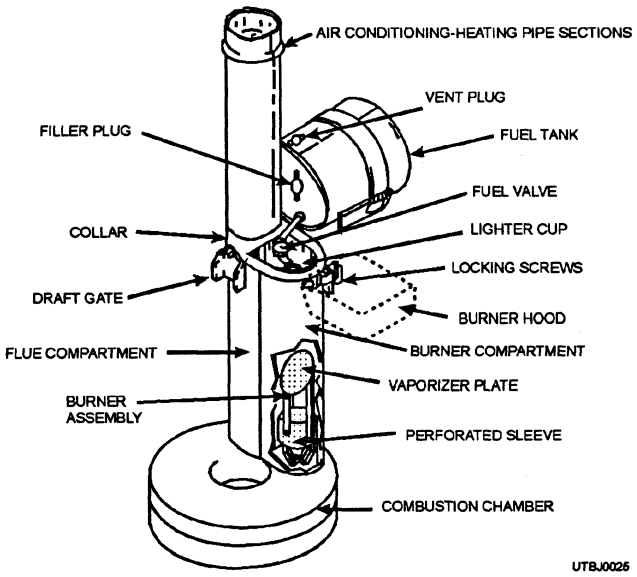


Figure 2-7.—Corrugated can, fuel fired, immersion heater.

compartment. Instructions for operation are located on the hinged hood that covers the top of the burner.

Use the following procedures when setting up the unit for use:

1. Place the immersion heater in a 32-gallon corrugated can and fill it until the water is 6 inches below the collar assembly of the heater.

2. Fill the fuel tank through the filler plug with unleaded or regular mogas and attach the fuel tank to the unit.

3. Assemble the four 2-foot sections of the flue and attach them to the unit.

The following steps are for operating the immersion heater:

1. Open the vent plug on the fuel tank and swing the lighter cup below the drip valve.

2. Open the drip valve until the lighter cup is 1/4 full of fuel.

3. Ignite the fuel in the lighter cup and return the cup into the flue. In approximately 1 minute, the flue will be preheated.

4. Swing the lighter cup so the edge of the cup is below the drip valve

5. Open the drip valve and the stream of fuel will ignite from the burning lighter cup.

6. Swing the lighter cup back into the flue and adjust the flow of fuel to just below smoke point.

> **WARNING**
> When the flow of fuel is excessive, an explosion may result. If dark smoke is coming out of the flue pipe, reduce the fuel flow.

FIELD RANGE BURNER UNIT

The portable field range used by the NCF has a self-contained burner unit that is portable. The burner unit can be used with a range unit or by itself. Figure 2-8 shows the M59 range unit and M2 burner unit.

When the M-59 range outfit is used for cooking or baking, the M-2 burner should be placed in the bottom position. When the cabinet is used for frying, the burner should be placed in the top position. The two burner positions are shown in figure 2-9.

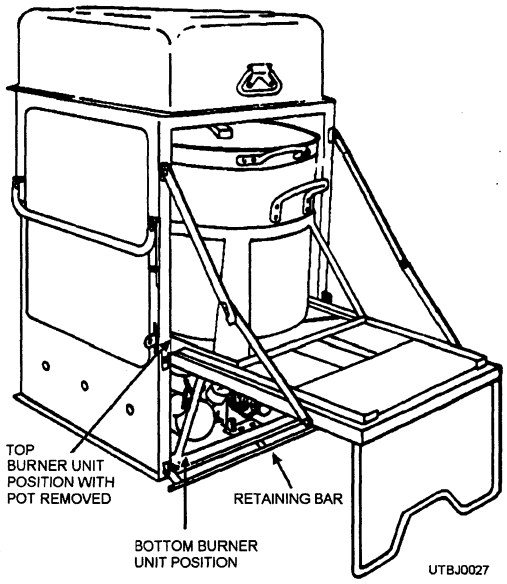


Figure 2-9.—Burner unit positions.

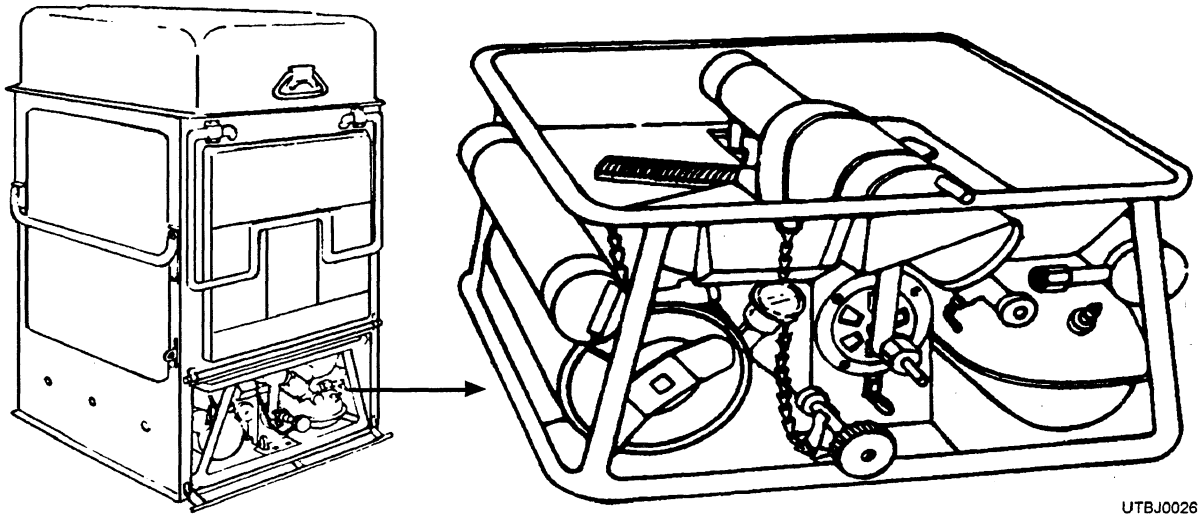
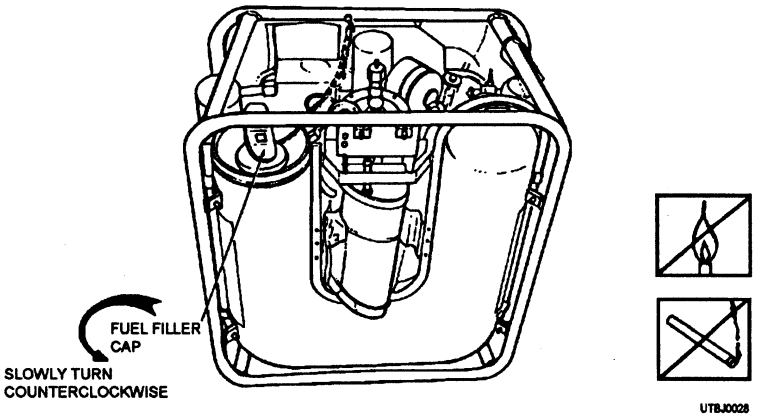
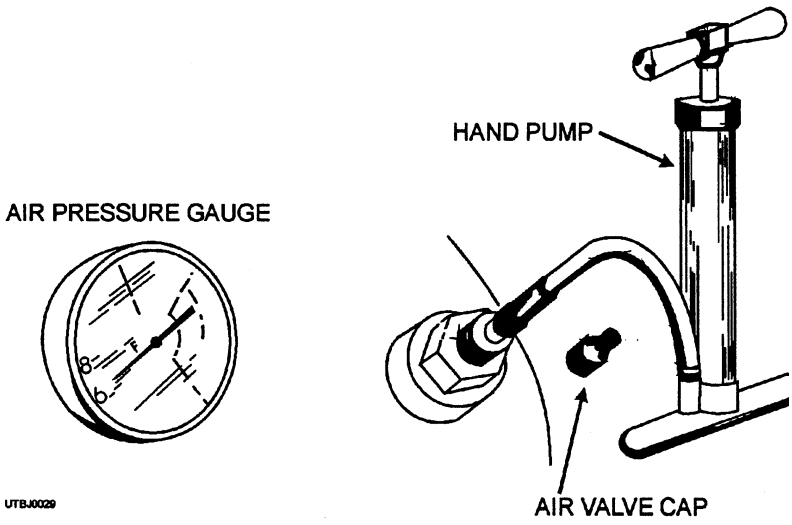
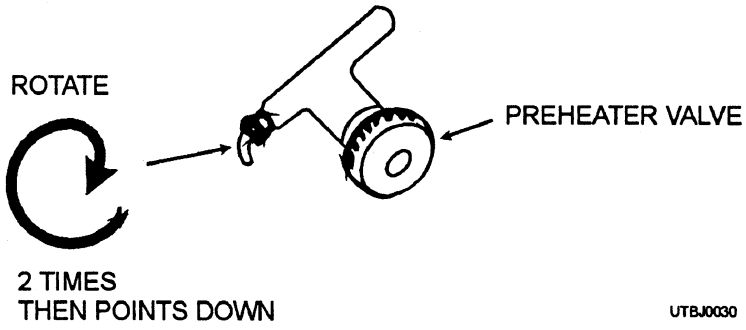


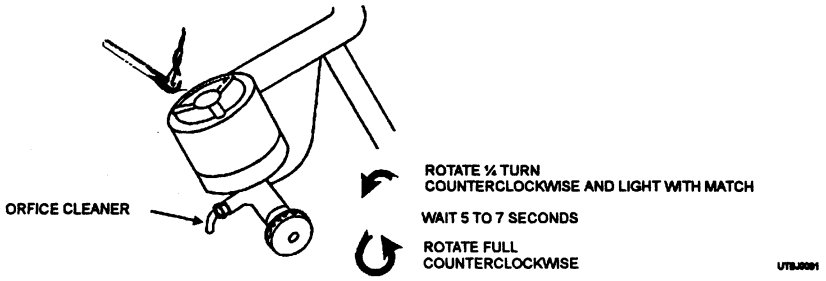
Figure 2-8.—M59 range outfit with M-2 burner.

The following inserts show the recommended way of setting up and operating the field range outfit.

Procedure	Insert
Take the burner unit to the fueling area at least 50 feet away from the lighting and cooking area. Place the burner in a vertical position and release the air pressure by turning the filler cap counterclockwise, then remove the filler cap. Fill with 8 quarts of mogas. Eight quarts will last approximately 4 hours.	
Take the burner unit 50 feet away from the fueling area and the cooking area. Place the unit in a horizontal position. Remove the air valve cap, place a hand pump on the valve, and pump until the pressure gauge reads 6-8 pounds. Remove the pump and replace the valve cap.	
Turn the orifice cleaning control completely around two or three times. When completed, the handle should point in the downward position.	

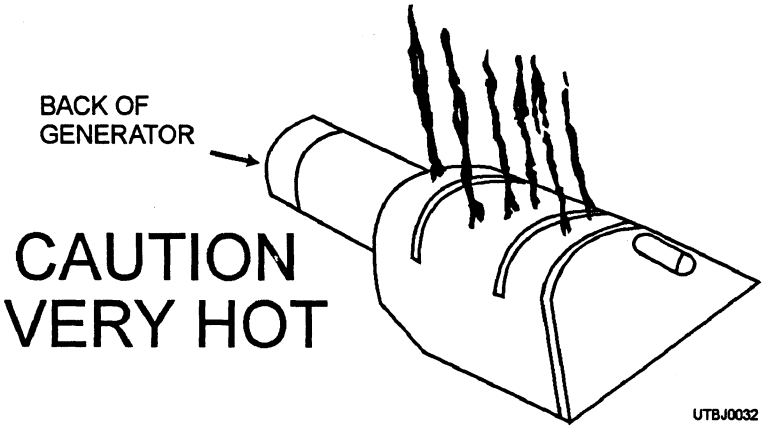
Procedure **Insert**

Place a lighted match close to the preheater head and turn the preheater valve one-quarter turn counter clockwise and ignite. Allow the preheater to burn 5 to 7 seconds or until the flame burns evenly. Now turn the preheater valve filly counterclockwise and place the preheater shield over the preheater.

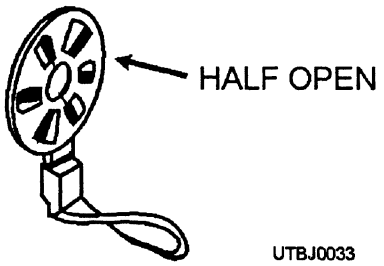


Allow the preheater to burn for 10 minutes or until the shield is hot to touch.

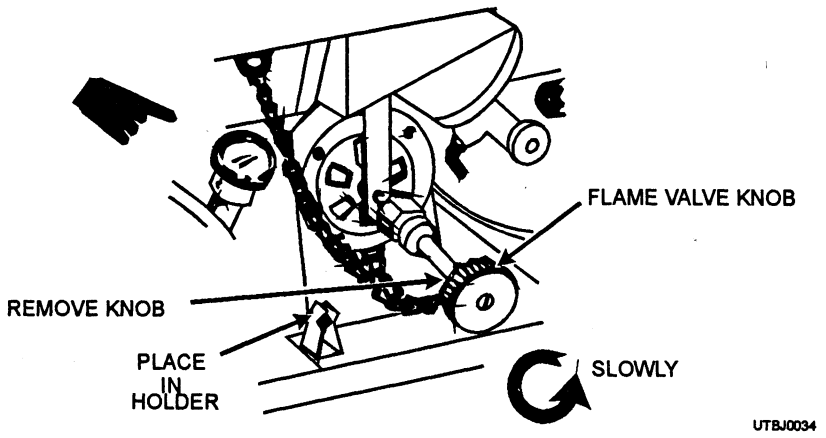
CAUTION: The preheater shield is very hot.



Open the air control shutter lever to half open.

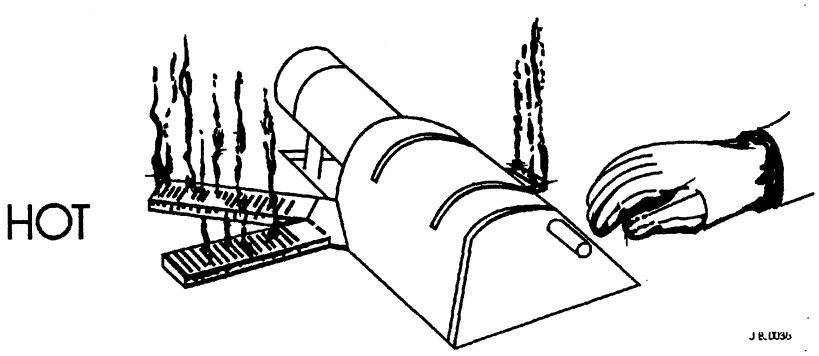


Remove the flame valve knob from the holder and place it on the valve. Slowly turn the knob counterclockwise to the fully open position.

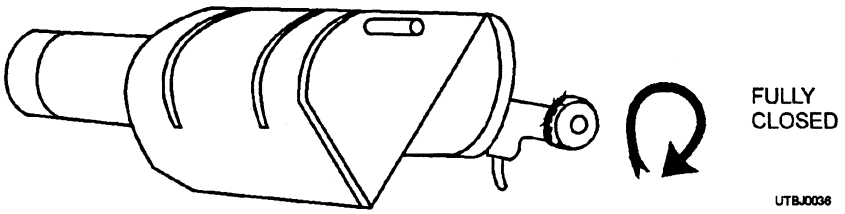


Procedure **Insert**

The burner should ignite. When lit, remove the preheater shield. Be sure that you use a glove when handling the heater shield.



Shut the preheater valve by turning it fully clockwise. Now turn the flame valve clockwise until the flame lowers to the height of the generator. Adjust the air shutter until the flame is green in color. Place the flame valve knob back in the holder.



Carry the burner unit to the cooking area and place it in the cabinet.

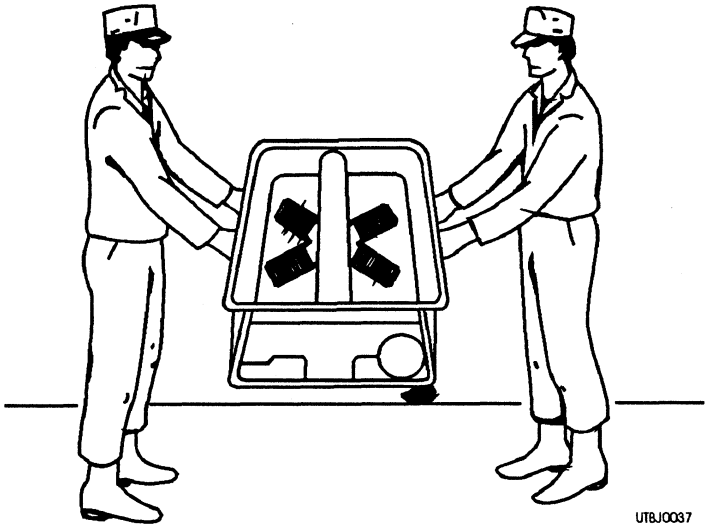
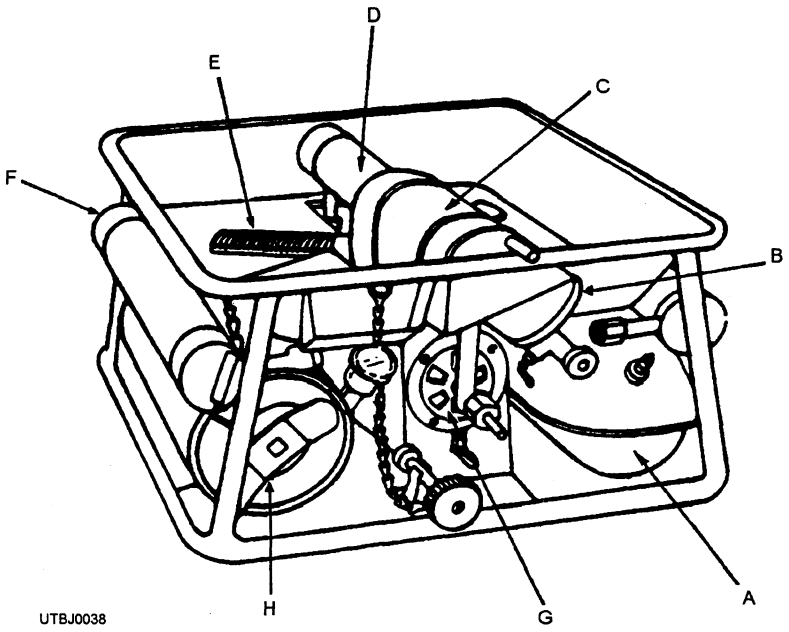


Figure 2-10 shows the location and describes the functionof the M-2 burner major components.

Figure 2-11 shows the operating controls of the M-2 burner.

CESSPOOLS, SEPTIC TANKS, TILE FIELDS, AND LATRINES

Various facilities are used for treatment and disposal of sewage at installations where common sewers are not available.



A. Fuel tank - Contains fuel to operate burner.

B. PREHEATER - Heats generator, which will then change fuel to gas vapor.

C. PREHEATER SHIELD - Helps generator heat up faster.

D. GENERATOR - Filters and converts liquid fuel into gas vapor.

E. BURNER - Spreads out the flame under cooking pots or pans.

F. SPARE GENERATOR - Replacement for defective generator.

G. AIR SHUTTER - Adjusts air input to burner.

H. FUEL FILLER - Provides an opening to place fuel in the unit.

Figure 2-10.—Location and description of burner major components.

These facilities include cesspools, septic tanks, tile fields, and field-type latrines. Information on each of these facilities is provided below.

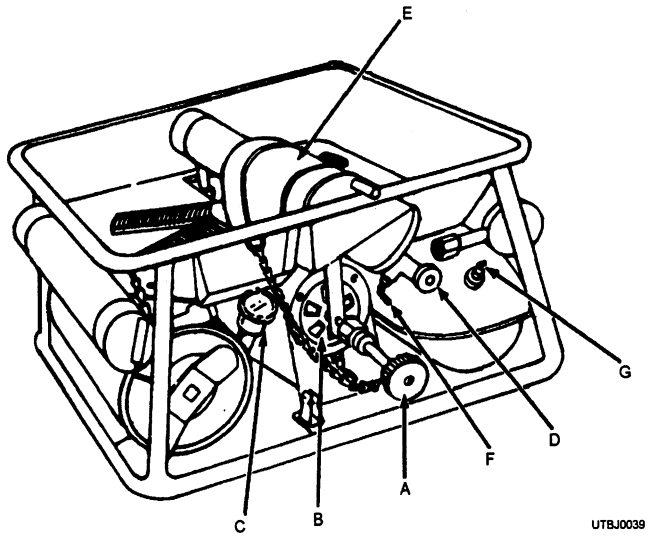
Cesspools

Leaching cesspools are usually dry-laid masonry or brick-lined wells without masonry at the bottom; the sewage flows into them and leaches out into the soil. Floating solids collect at the top and settling solids collect at the bottom of the well. The leaching capacity of the well is exhausted when the solids accumulate and clog the soil (fig. 2-12). The use of chemicals is not recommended for increasing the useful life of a cesspool.

When the first cesspool becomes filled, a second well may be constructed to take the overflow from the first. In such cases, the first cesspool should operate as a septic tank to collect the settling and floating solids and provide a trapped outlet on the connection leading to the next leaching cesspool. Septic tanks can be placed advantageously ahead of leaching cesspools in larger installations. Leaching cesspools should not be placed closer together than 20 feet by out-to-out measurement of the walls.

Leaching cesspools should be used only where the subsoil is porous to a depth of at least 8 or 10 feet and where the groundwater is below this elevation. When cesspools are located in fine sand, the leaching area can be increased by surrounding the walls with graded gravel.

The number and the size of cesspools required depend on the quantity of sewage and the leaching characteristics of the total exterior percolating area above the groundwater table, including bottoms and sidewalls below the maximum-flow lines. The allowable rate of sewage application per square foot per



A. GENERATOR KNOB, FLAME VALVE - Fuel adjustment to burner.

B. AIRCONTROL SHUTTER VALVE - Air input adjustment to burner.

C. AIR PRESSURE GAUGE - Air input adjustment to burner

D. PREHEATER VALVE - Inputs gas to preheater.

E. GENERATOR PREHEATER SHIELD - Contains heat while gas is vaporizing.

F. ORIFICE CLEANER - Cleans orifice in preheater.

G. AIR VALVE - Hand pump attachment used to pressurize fuel tank.

Figure 2-11.—Burner operating controls.

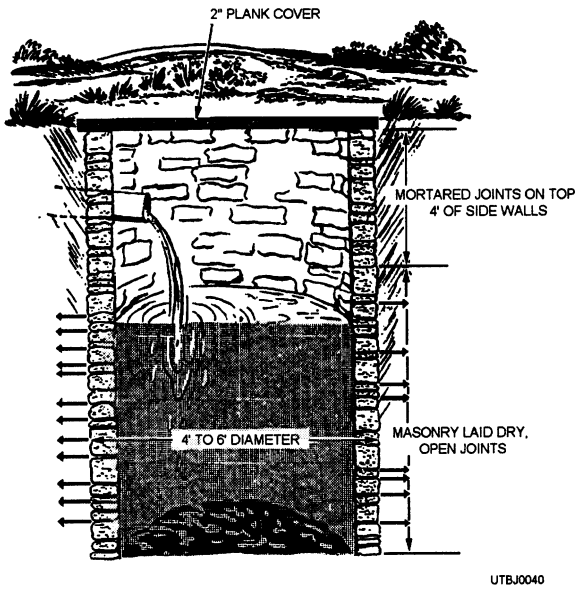


Figure 2-12.—Leaching cesspool.

day, based on the recommended leaching test, is provided below. Soils that require more than 30 minutes for a fall of 1 inch are unsatisfactory for leaching, and some other disposal method must be used.

Time for water to fall 1 inch (minutes)	Allowable rate of sewage applicable (gallons per square foot of percolating area per day)
1	5.3
2	4.3
5	3.2
10	2.3
30	1.1

The test for leaching should be made by digging a pit about one half of the proposed depth of the cesspool, making a test hole 1 foot square and 18 inches deep at the bottom. The test hole is filled with 6 inches of water that is allowed to drain off. Six inches of water is again

added, and the downward rate of percolation is measured in minutes required for the water surface to lower 1 inch in the hole.

Septic Tanks

For emergency and temporary construction, septic tanks are made of wood or nonreinforced concrete with wood covers and baffles. Reinforced concrete construction is more suitable for permanent installations (fig. 2-13). The tank capacity should equal a full day's floss, plus an allowance of from 15 to 25 percent for sludge capacity. The minimum size of a tank required by code is 1,000 gallons.

In constructing a septic tank, be sure the length of the septic tank is not less than two, or more than three times the width. The liquid depth should not be less than 4 feet for the smaller tanks and 6 feet for the larger ones. Manholes should be provided over the inlet and outlet pipes and over the low points in the bottom of hopper bottom tanks. The roof of the tank may be covered with earth, but access openings should extend at least to the ground surface. Although ells or tees may be used at inlet and outlet connections, straight connections are better for rodding (cleaning out). Instead of ells, wooden baffles, located approximately 18 inches from the ends of the tank and extending 18 inches below and 12 inches above the flow line, are provided. Elevations should permit free flow into and out of the tank. The bottom of the inlet sewer should be at least 3 inches above the water level in the tank. The inlet and outlet connections should be sufficiently buried or otherwise protected to prevent damage by traffic or frost.

Although septic tanks that are designed properly require little operating attention, they must be inspected periodically; the frequency of inspection is determined by the size of the tank and the population load. The minimum frequency should be once every 2 months at periods of high flow. The inspection should be made to assure that the inlet and outlet are free from clogging, the depth of scum and sludge accumulationis not excessive, and the effluent passing to subsurface disposal is relatively free of suspended solids. A high concentration of suspended solids in the effluent clogs subsurface disposal facilities quickly. Sludge and scum accumulation should not exceed one fourth of the tank capacity. It should not be assumed septic tanks liquefy all solids, they never need cleaning, and the effluent is pure and free of germs. Perhaps 40 to 60 percent of the suspended solids is retained, and the rest is discharged in the effluent.

Separating sludge and scum from the liquid in septic tanks is difficult. In small tanks, these wastes are customarily mixed; the entire contents are removed when the tanks are cleaned. The material removed contains fresh or partially digested sewage solids that must be disposed of without endangering the health of personnel. Disposal through manholes in the nearest sewer system, as approved by local authorities, or burial in shallow furrows on open land is

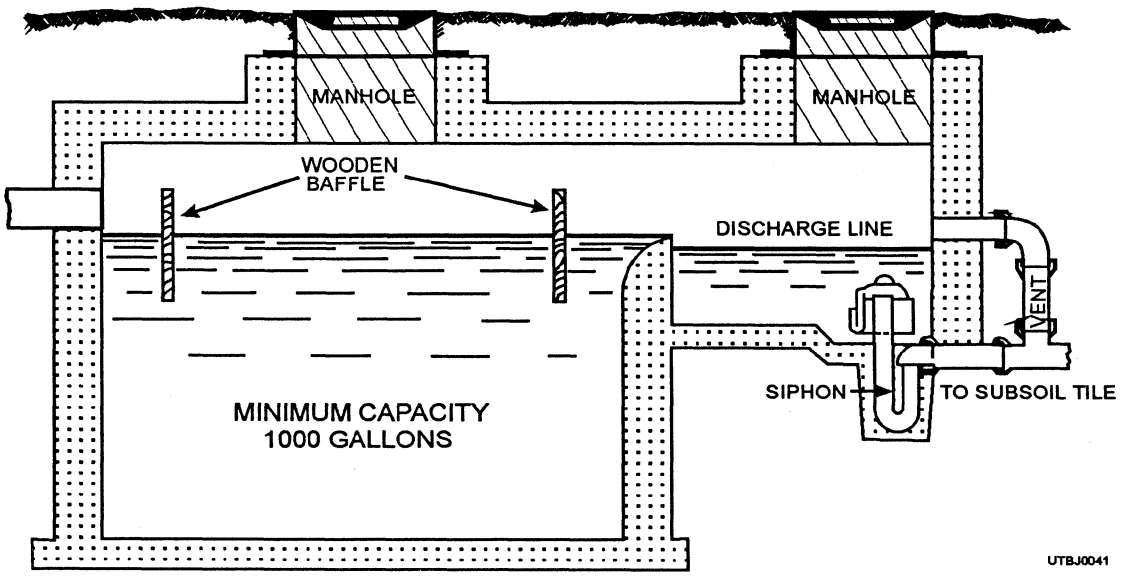


Figure 2-13.—Septic tank.

recommended. A diaphragm sludge pump is best suited for removing the tank contents that should be transported in a watertight, closed container. Trucks are made that specifically pump and carry the waste material to a place where it can be disposed of.

Tile Fields

Tile fields of lines made of concrete, clay, or PVC are laid in the ground with open joints or perforations to dispose of settled sewage into the ground. A fiber pipe (Orangeburg Alkacid) or plastic pipe with holes bored in the lower portion of the pipe to allow drainage may be used for these drain lines. This pipe is light in weight and is easily laid in the trench. It comes in sizes ranging from 2 inches to 8 inches in diameter and in lengths from 5 feet to 8 feet. Because of these long lengths, this type of pipe is particularly valuable in soil where other types of pipe may settle unevenly. Figure 2-14 shows a typical field layout.

PROPER FUNCTIONING.—The following conditions are important for proper functioning of tile fields:

- Groundwater well below the level of the field
- Soil of satisfactory leaching characteristics within a few feet of the surface, extending several feet below the tile
- Subsurface drainage away from the field
- Adequate area
- Freedom from possibility of polluting drinking water supplies, particularly from shallow dug or driven wells in the vicinity

TESTS.—The length of tile and details of the filter trench generally depends upon the character of the soil. Soil leaching tests should be made at the site, as described for leaching cesspools, except the test hole should extend only to the approximate depth at which the tile lines are to be laid. For extensive tile fields,

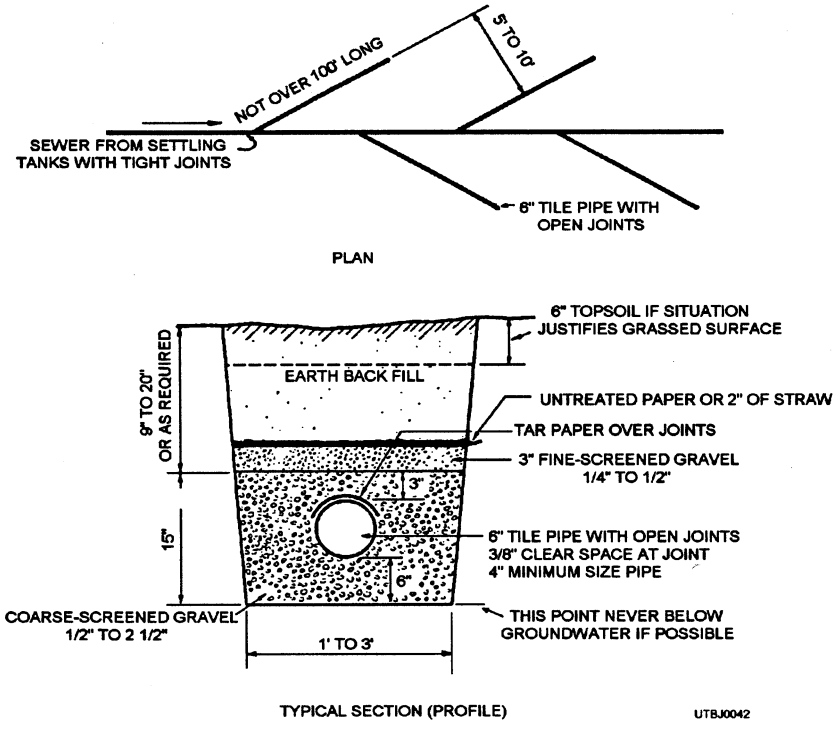


Figure 2-14.—Typical layout of a subsurface tile system.

several tests to determine the best location and average conditions should be made. From test results, the rate of sewage application to the total bottom area of the tiled trenches may be taken from the data below. Soil testing over 30 minutes is not suitable.

Time for water to fall 1 inch (minutes)	Allowable rate of sewage application in gallons per square foot per day, bottom of trench in tile field
1	4.0
2	3.2
5	2.4
10	1.7
30	0.8

TRENCH WIDTH.—The minimum width of a trench on the basis of the types of soil is as follows:

- Sand and sandy loam, 1 foot
- Loam and sand and clay mixture, 2 feet
- Clay with some gravel, 3 feet

FROST LINE.—Placing tile below the frost line to prevent freezing is not necessary. Tile placed 18 inches below the ground surface operated successfully in New England for many years. Subsurface tile should never be laid below groundwater level.

PIPE SIZE.—Design and construction should provide for handling and storage of some solid material, eliminating, as much as practical, the opportunity for clogging near pipe joints. Pipe 4 to 6 inches in diameter is recommended. The larger pipe gives greater storage capacity for solids and a larger area at the joint for solids to escape into the surrounding gravel.

LAYING THE PIPE.—To provide for free discharge of solids from the line to the filter trench, lay the pipe with 3/8-inch clear openings. The top of the space is covered with tar paper or similar material to prevent entry of gravel. Bell-and-spigot pipe is laid to true line and grade easily. Good practice calls for breaking away two thirds along the bottom of the bells at the joint and rising small wood-block spacers. The pipe is commonly laid at a slope of about 0.5 foot per 100 feet when taking the discharge directly from the septic tank and 0.3 foot per 100 feet when a dosing tank is used ahead of the field.

BEDS.—The tile is laid on a bed of coarse-screened gravel at 6 inches deep with 3 inches of coarse gravel around and over the pipe. Coarse-screened stone passing 2 1/2-inch mesh and retained on a 3/4-inch mesh is recommended. This gravel bed gives a relatively large percentage of voids into which the solids pass and collect before the effective leaching area becomes seriously clogged. The soil that fills the trench must not fill the voids in the coarse-screened gravel around the pipe. A 3-inch layer of medium-screened gravel over the coarse stone and 3 inches of either fine-screened gravel or suitable bank-run gravel over the medium stone is recommended.

LAYOUT.—The layout of the tile in the field should be designed carefully. Generally, the length of laterals should NOT exceed 100 feet. When tile is laid in sloping ground, distribute the flow so each lateral gets a fair portion. Flow must be prevented from discharging down the slope to the lowest point. Individual lines should be laid nearly parallel to land contours (fig. 2-14). Tile fields are laid out either in a herringbone pattern or with the laterals at right angles to the main distributor. The distance between laterals is three times the width of the trench. Distribution boxes to which the laterals are connected may be desirable. Trenches, 24 inches wide or more, are economical. When a trenching machine is practical on a large installation, base the design on the width of the trench excavated by the machine.

PROTECTING THE FIELD.—Once constructed, all traffic must be excluded by fencing or posting the tile field to prevent crushing of the tile. Planting shrubs or trees over the field is not good practice since the roots tend to clog the tile lines; grass over the lines aids in removing moisture and keeping the soil open.

Field-Type Latrines

Upon arrival at an advanced base, temporary facilities must be provided immediately for the disposal of human waste. A number of designs of field-type latrines are used for this purpose. A 16. by 32-foot wood-frame tent may be used to shelter the field-type latrine.

A prefabricated four-seat latrine box is shown in figure 2-15. This box can be collapsed for shipment, as shown in figure 2-16.

A plan view of an eight-seat field-type latrine is shown in figure 2-17. As shown, the eight-seat field-type latrine can be expanded to a 1 B-seat latrine. With this type of latrine, two 4-seat boxes are placed to straddle a 3- by 7-foot pit. After the pit is dug and before the boxes are placed, a 4-foot-wide margin around the pit is excavated to a depth of 6 inches, as shown in figure 2-18. A layer of oil-soaked burlap is laid in this excavation; then the excavated earth is soaked with oil, replaced, and tamped down to keep out surface water. Two 4-foot 6-inch trough-type urinals are furnished with the eight-seat latrine. Each urinal is mounted in a frame constructed as shown in figure 2-19. A 2-inch urinal drainpipe leads from the downpipe on each urinal to a 6- by 6-foot urinal SEEPAGE PIT, located as shown in figure 2-l 9. The seepage pit is constructed as shown in figure 2-20.

A four-hole burnout field-type latrine is used at most advanced or temporary bases. The burnout latrine is kept in an orderly condition (daily) by camp maintenance personnel or by the sanitation crew assigned. Two people can effectively and efficiently dispose of the excremental waste of 500 people. There are two easy ways of maintaining the burnout latrine. They are as follows: by spreading lime over the waste material or by using diesel fuel to burn the waste material. The burning pit for the waste material should be located so resulting smoke, fumes, odors, and blowing ashes do not interfere with operations or the health and general well-being of personnel.

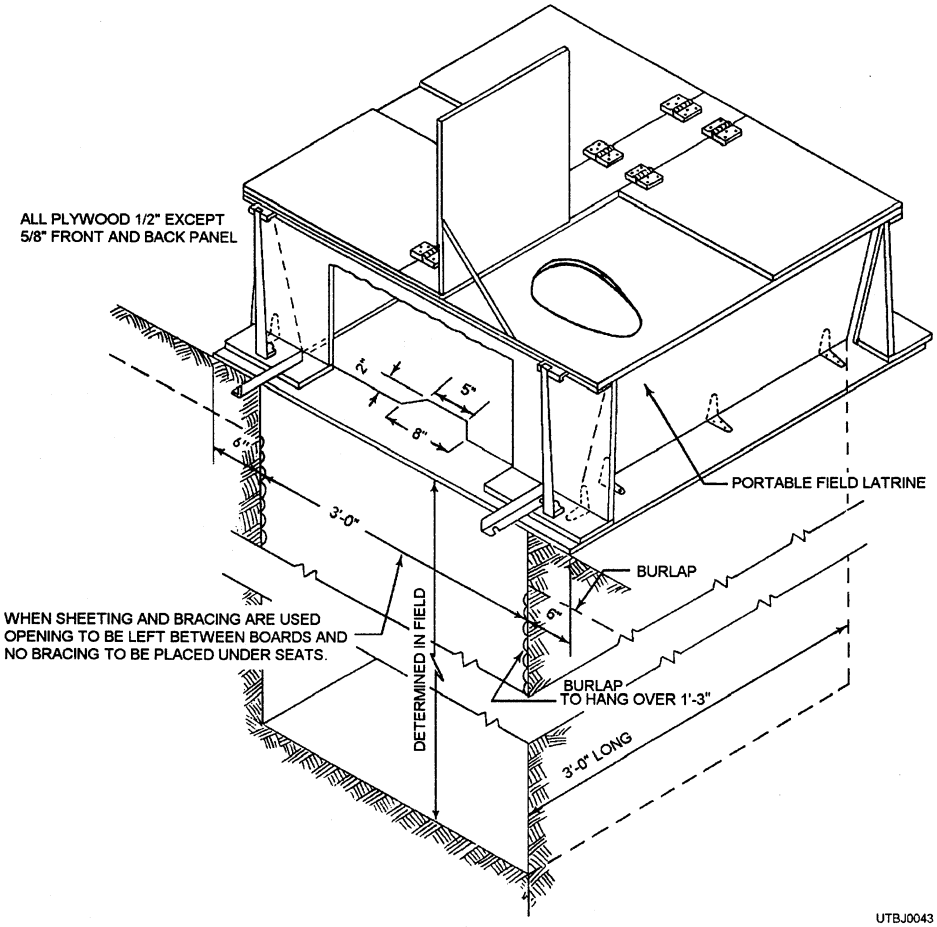


Figure 2-15.—Prefabricated four-seat latrine box.

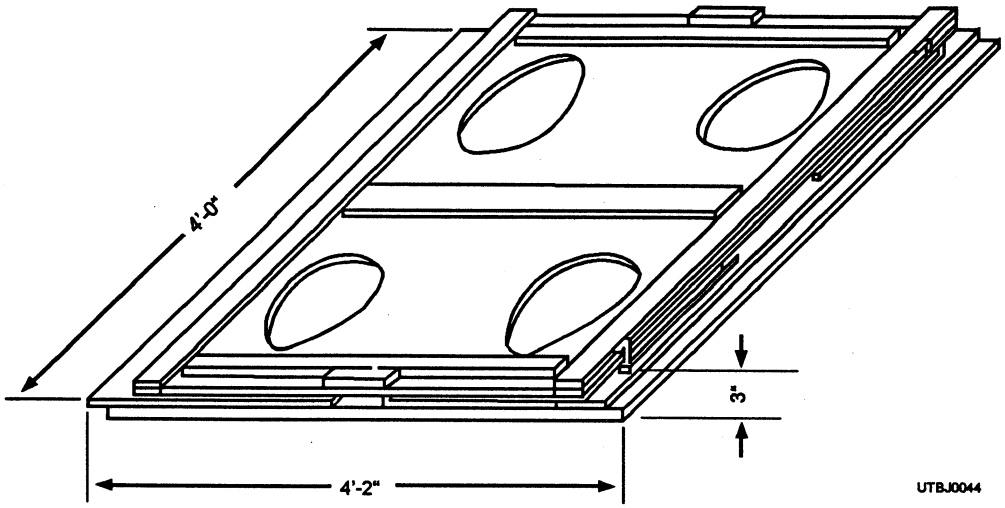


Figure 2-16.—Latrine box collapsed for shipment.

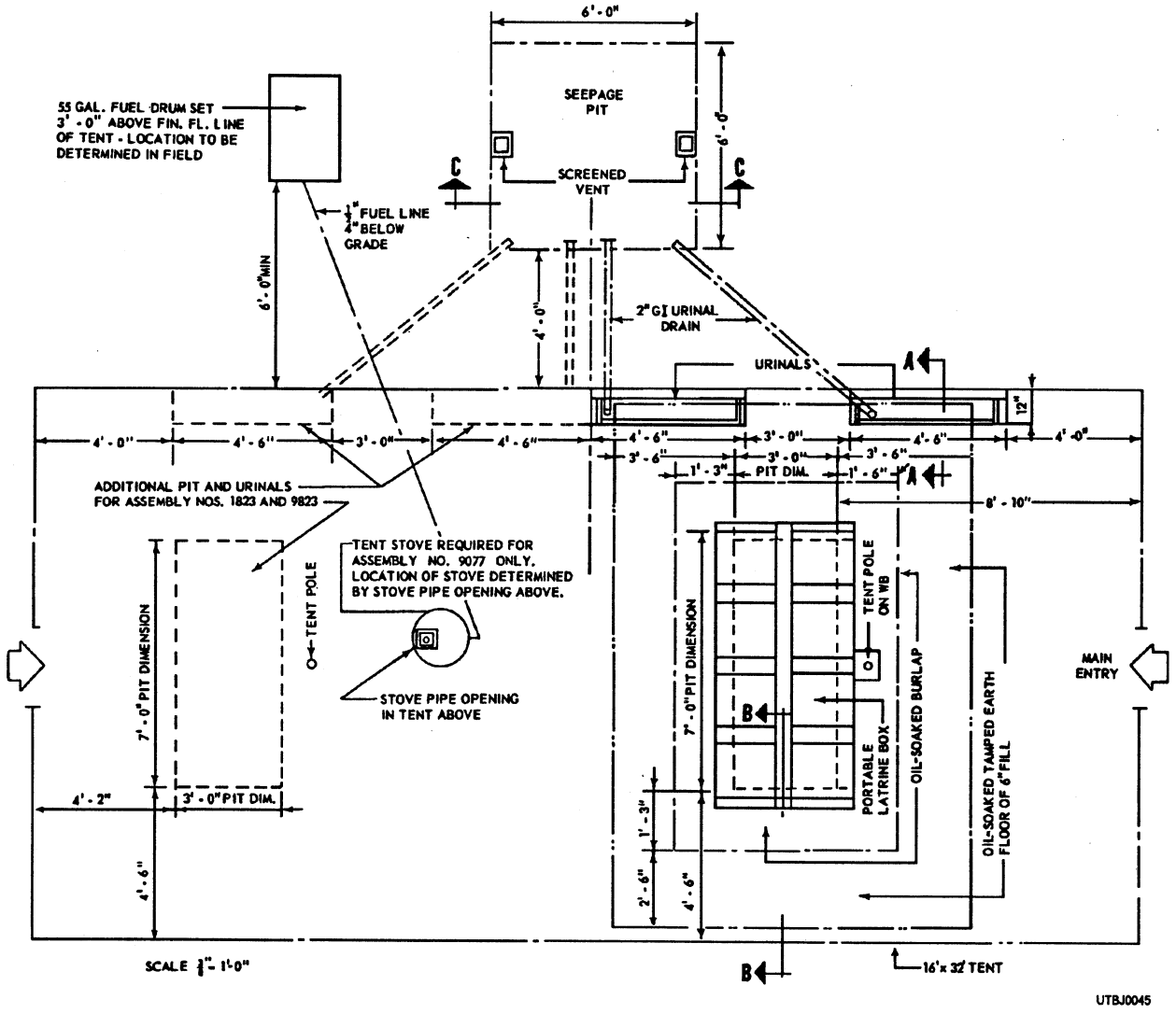


Figure 2-17.—Plan view of an eight-seat field-type latrine.

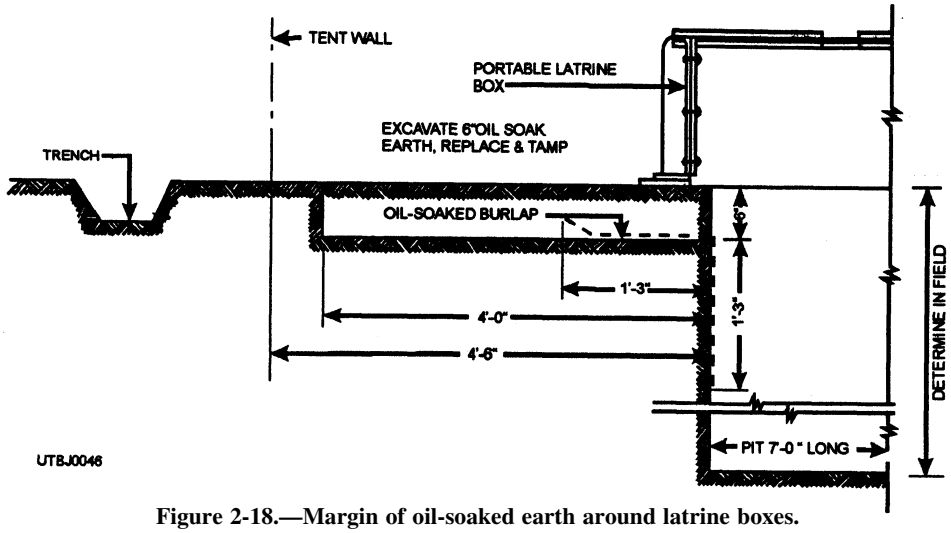


Figure 2-18.—Margin of oil-soaked earth around latrine boxes.

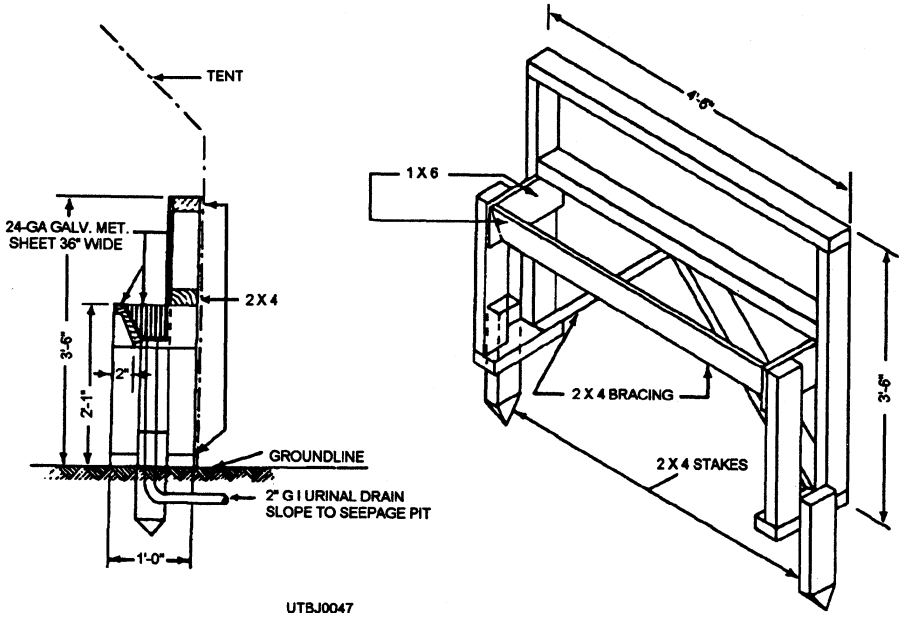


Figure 2-19.—Frame for urinal trough.

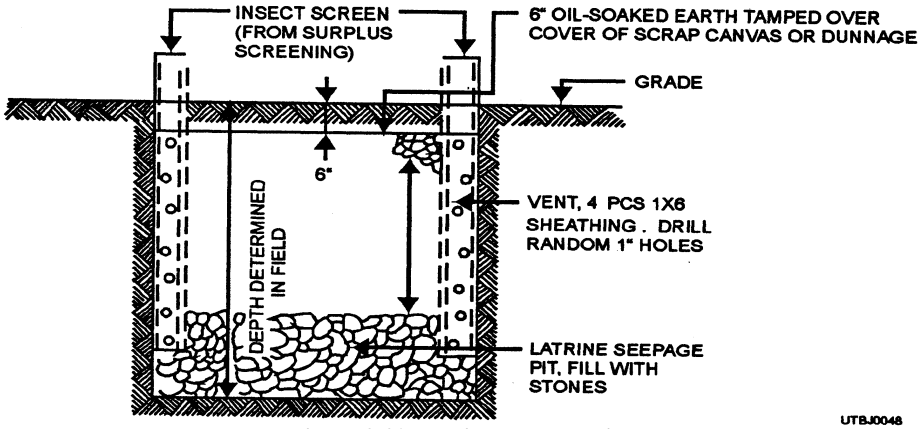


Figure 2-20.—Urinal seepage pit.

GALLEY WASTE

The wastewater in the galley sewer normally contains a large amount of grease; therefore, a grease trap must be installed in the sewer system to intercept and collect grease. A typical grease trap, which can be constructed in Bravo company shops, is shown in figure 2-21. This trap allows grease to enter the sewer system, to congeal, and to float to the top of the barrels. At a minimum, the grease must be removed once daily from the trap and disposed of, usually by burning. A properly constructed and maintained grease trap helps to ensure proper operation of the leach field that disposes of the wastewater.

LAUNDRY UNIT

Laundry units are installed after the advanced base has been established and essential support equipment is in place. You will encounter units similar to the one shown in views A, B and C of figure 2-22. The laundry unit shown in figure 2-22 is shown in a more permanent location This oil-fired, skid-mountedlaundryunit (fig. 2-22) is comprised of a washer, a dryer, a moisture extractor, a centrifugal water pump, and a water heater with a pressurized water storage tank.

A description of the major components of the skid-mounted laundry unit is listed below.

The Milnor washer is a fully automatic or manually operated unit with a 50-pound or 100-pound load capacity. It is supplied with a programmable cycle control and an automatic supply injector and uses 125 gallons of water per wash cycle.

The Cissell L36SMS30 model dryer or tumbler has a drying capacity of 50 pounds (dry weight) of laundry perhourandaheatingcapacityof 130,000 Btu per hour. It has a temperature-regulating thermostat, drying timer, cool-down timer, and a start/stop button.

The Bock 205 model moisture extractor extracts water from the clothes after rinsing by spinning the clothes at a high rate of speed, applying centrifugal. force, pushing the water to the outer surface, and discharging it through the basket. The extractor is equipped with a programmer that can be set for a 1- to 10-minute cycle.

The centrifugal water pump has a self-priming volute impeller. The only movable parts are the impeller, seal rotating elements, and shaft. The pump should pull a minimum vacuum of 20 inches of mercury.

The water heater is equipped with a fuel unit assembly, oil burner control relay, ignition transformer, fuel pump, and “drawer assembly," consisting of electrodes, insulators, nozzle adaptor, electrode support, and flame sensor, or “fire eye.”

Different sizes of storage tanks with a capacity ranging from 6 to 85 gallons can be fitted to the skid when the unit is ordered. The storage tank has a maximum operating pressure of 100 psi.

In the paragraphs that follow, generic information is provided about installation, start-up, operation, and securing of this particular unit. This information is not all-inclusive nor intended for all types of units. As each laundry unit configuration is slightly different from the next, you should always refer to the instruction technical manual for the particular unit you are using.

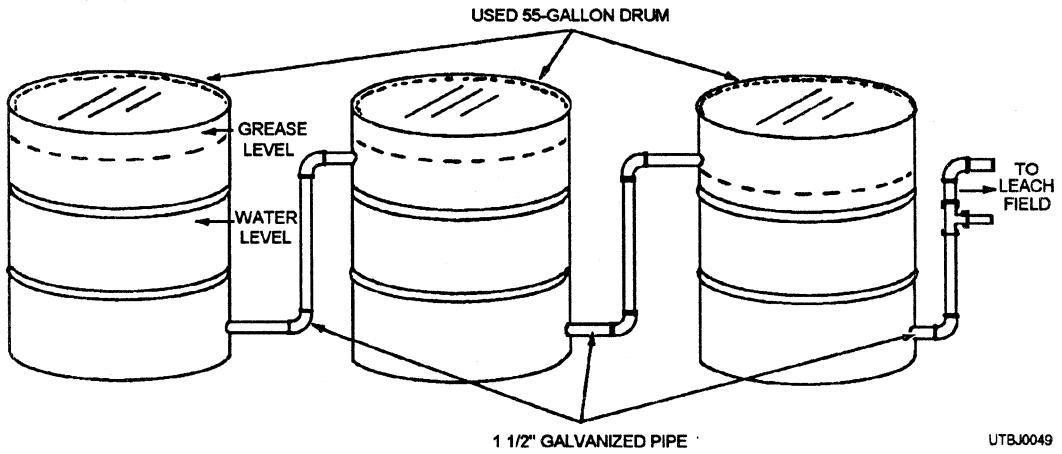
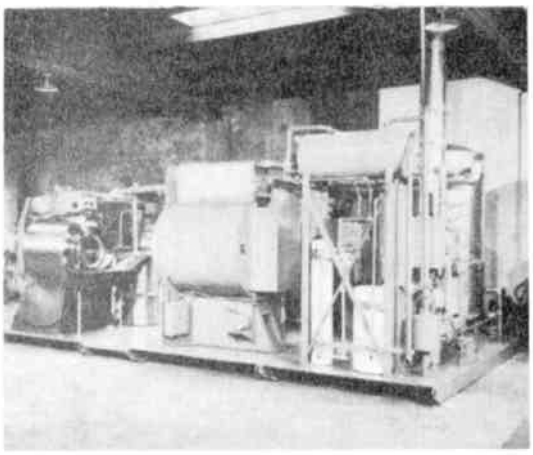
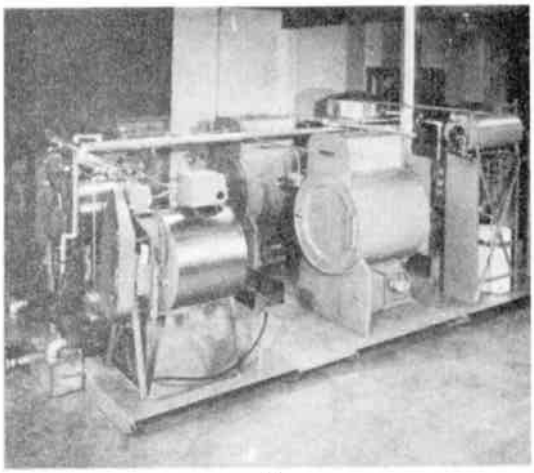


Figure 2-21.—Field galley grease trap.



A.



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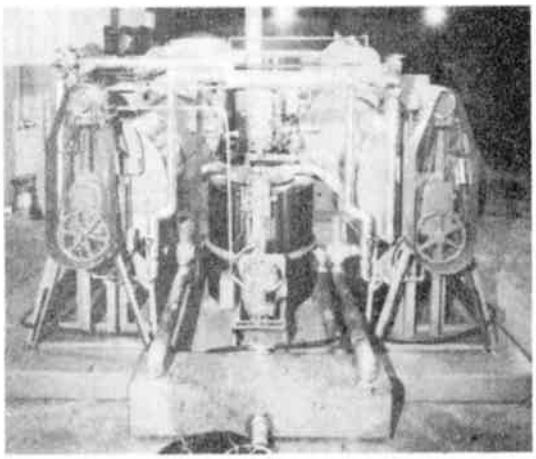

C.

Figure 2-22.—Skid-mounted laundry unit.

Start-up

Place the unit on a level surface as close to the intended water and electrical source as practicable. Inspect the unit for damage due to transport or installation.

Check the mounting bolts to ensure they are secure. Component mounting bolts are factory-torqued. If bolts are loose, refer to the manufacturer's specifications and use a torque wrench to reset them.

Carefully perform all duties and prestart checks indicated in the manufacturer's operation manual.

Each time the unit is moved or disconnected, the following start-up procedures should be followed:

- Remove the rib holder assembly from the dryer drum before supplying power to the unit.
- Attach the line from the water source to the pump.
- Attach the drain hose to the drain and flex duct hose to the dryer exhaust. Both are supplied with the unit.
- Attach the fuel line supply and return from the source to the unit.
- Connect the power line to the power source.
- Open the water shutoff valve and then open the air-relief valve. Close the air-relief valve after all the air has been bled from the waterline.
- Switch the main breaker to ON.
- Switch the pump breaker to ON. Check the pump operation.
- Open the fuel valves on the unit.
- Switch the dryer breaker to ON. Be sure to bleed the fuel line. Read the dryer operating instructions carefully.
- Allow the water heater to fill before switching the breaker to ON. Be sure to bleed the fuel line. Read the water heater operating instructions.
- To ensure complete filling of the water heater, open the pressure-relief valve to permit trapped air to escape. When the water begins to run out of the pressure-relief valve, close the valve.
- Switch the washer and moisture extractor breakers to ON. The laundry unit is now ready for use.

Operation

The purpose of this laundry unit is to wash, extract water, and dry clothes and other suitable materials. The washing process is a series of baths during which soil is loosened from the materials, suspended in the water, and finally rinsed away. Several baths are usually necessary to remove the soil completely.

Operation is controlled by a timer and removable FORMULA CHART located in the washer, which regulates water temperature, wash rinse cycle, and adding of supplies. The chart carries the unit through a complete cycle according to the formula cut into the chart (up to 88 minutes). This chart can be changed at the discretion of the operator. The washer has an automatic supply injector unit that consists of five compartments that facilitates addition of starch, dry soap, and bleach before and during the washing cycle.

The extractor is simple in operation and is controlled by a moisture programmer located inside the control panel. The programmer is adjustable with a 1-minute to lo-minute time range. Once set, the extractor will run at the set time each time the start button is depressed.

The dryer, or tumbler, is operated by three different controls that are manually set by the operator. These controls are as follows:

- Temperature regulating thermostat sets the basket outlet temperature as determined by the material being dried.
- The drying timer sets the time duration for drying. It can be set from 0 minutes to a maximum of 60 minutes.
- The cool-down timer controls the allowed cool-down time for materials being dried. This control can be set from 0 to 15 minutes.

More specific operation, maintenance, and troubleshooting information is contained in the Utilitiesman Basic, Volume 2, Chapter 7, Laundry Equipment, NAVEDTRA 11020.

Securing the Unit

Before transporting or relocating the unit, you must secure it properly to prevent damage and extend the operational life of the unit. As each unit may be somewhat different, general securing procedures are as follows:

- Turn the unit OFF and empty all components.
- Switch all breakers to OFF.
- Open the drain valve on the pump assembly, and open the pressure-relief valve on the water heater.
- Replace the rib holder assembly in the dryer drum.
- Close the water and fuel valves. Disconnect the fuel and water sources.
- Disconnect and store the following components:
  a. Dryer'flex hose; store it in the tumbler.
  b. Power line; store it in the washer.
  c. Drain hose; store it in the washer.
- Remove the drain plug on the pump and let the water out. After draining is complete, replace the plug.
- When all the water has drained from the system, close the drain and pressure-relief valves.

WATER PURIFICATION UNITS

The remainder of this topic concerns the NCF water purification equipment. One of the most important jobs as a Utilitiesman is the purification of water.

Insufficient quantity or quality of water is not only debilitating to the individual but has a significant impact on unit readiness. Water that is not properly treated and disinfected can spread bacterial diseases, such as cholera, shigellosis, typhoid, and paratyphoid fever. Untreated water can also transmit viral hepatitis, gastroenteritis, and parasitic diseases, such as amoebic dysentery, giardiasis, and schistosomiasis.

The treatment process includes one or more of the following processes: coagulation, sedimentation, filtration, and disinfection.

The medical department advises the commanding officer on water quality issues. This entails assisting the Utilitiesman in selecting water sources, surveying the potable water system, conducting routine bacteriological examination of the potable water supplies, and testing the water for halogen levels. The medical representative also informs the Utilitiesman of water quality and type of treatment required, if any.

Lyster Bag

The lyster bag shown in figure 2-23 is primarily a dispensing unit for purified or distilled water. These bags are sturdy, watertight, and readily collapsible for packing. Water is withdrawn through small faucets at the bottom. When no other purification equipment is available, the lyster bag can be used to disinfect raw water. Chemical kits for purification are supplied with each lyster bag. When you must use a lyster bag for water treatment, follow the manufacturer's instructions.

Tank Trailers

Tank trailers (fig. 2-24), like lyster bags, are designed as dispensing units for purified or distilled water; however, tank trailers may be used to disinfect raw water. The water is treated as directed by local medical authorities.

The tank trailer, sometimes referred to as a "water buffalo," has a capacity of 400 gallons of water. The unit comes equipped with faucets for dispensing the water. When desirable, water can be transferred from the tank trailer into a lyster bag. The responsibility for cleaning and disinfecting the tank trailer before it is filled with water belongs to the Utilitiesman.

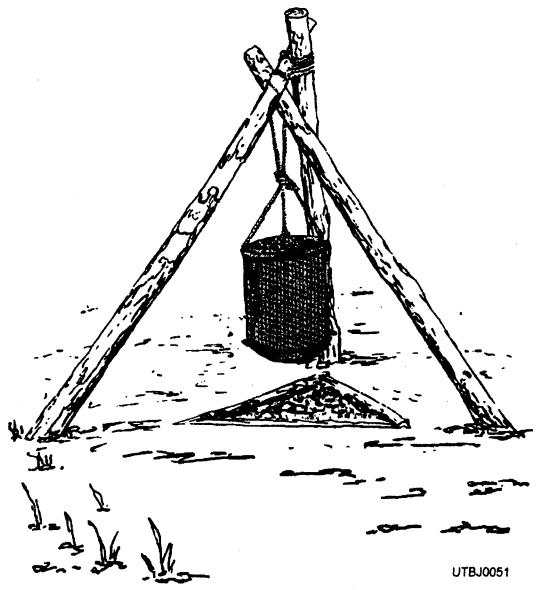

Figure 2-23.—Lyster bag.

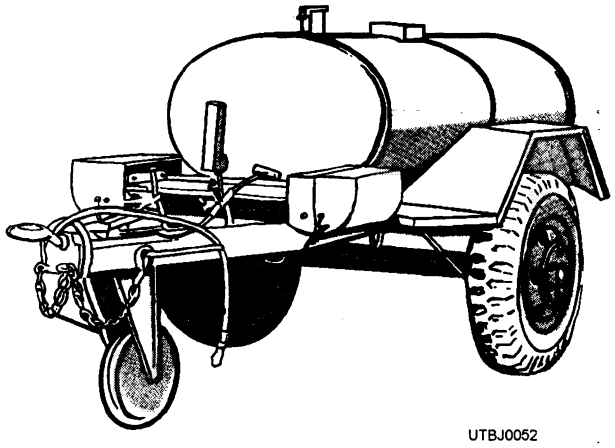

Figure 2-24.—Tank trailer.

Disinfection

Disinfection destroys harmful organisms (pathogenic viruses, bacteria, and protozoans) present in water by exposing them to specific concentrations of disinfecting agents or to heat. The Navy guidelines on disinfection are as follows.

The superchlorination process is used to disinfect water containers (lyster bags, tank trailers, etc.) and distribution systems initially- before they are used or when they have become contaminated. Superchlorination is accomplished by chlorinating the water in a container or distribution system to at least 100 ppm FAC and holding it in the container for 4 hours. During the 4-hour period, the FAC must not drop below 50 ppm. If the ppm falls below 50 ppm the process must be repeated. A sign "POISON DO NOT DRINK" must be displayed clearly on all sides of the container or at all water outlets during this process.

Using the three charts in table 2-2, choose the one that applies to the percentage of HTH material you intend to use. Let's say the chief gave you a bottle of 65% granular calcium hypochlorite. You should use the chart that has the title "For 65% to 70% Granular Calcium Hypochlorite." Now locate the amount of water you are going to treat. For our example here, let's say that we are going to treat a 400-gallon tank trailer. Look on the correct chart and locate the quantity in gallons. There is no 400-gallon figure, so use the larger capacity of 500 gallons. Now follow over on the chart and locate the corresponding number of ounces to add to receive a 100 ppm FAC. The answer is 10 ounces. We have determined that 10 ounces of 65% calcium

Table 2-2.—Chlorine Dosage Calculator

Instruction for use: Select desired parts per million. Determine strength of solution to be used. Compute number of gallons to be chlorinated. Read across to where lines intersect to obtain quantity of material to be used.

Desired PPM	1	1	1	1	5	5	5	5	25	25	25	25	50	50	50	50	100	100	100	100	200	200	200	200
Strength of chlorine solution	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%	5%	25%	70%	100%
Gallons of water to be chlorinated																								
50,000	1 Gal	1 1b 11oz	10 oz	6.7 oz	5 Gal	8 lb 6 oz	3 lb	2 lb 2 oz	25 Gal	41 lb 12 oz	14 lb 15 oz	10 lb 7 oz	50 Gal	83 lb 7 oz	30 lb	20 lb 14 oz	100 Gal	166 lb 13 oz	59 lb 10 oz	41 lb 12 oz	200 Gal	333 lb 10 oz	119 lb 4 oz	83 lb 7 oz
25,000	2 Qt	134 oz	5 oz	3.34 oz	2.5 Gal	4 lb 3 oz	1 lb 8 oz	1 lb 1 oz	125 Gal	20 lb 14 oz	7 lb 8 oz	5 lb 4 oz	25 Gal	41 lb 12 oz	15 lb	10 lb 7 oz	50 Gal	83 lb 7 oz	29 lb 13 oz	20 lb 14 oz	100 Gal	166 lb 13 oz	59 lb 10 oz	41 lb 12 oz
10,000	25.6 oz	5.5 oz	2 oz	1.34 oz	1 Gal	1 lb 11 oz	9.6 oz	6.72 oz	5 Gal	8 lb 6 oz	3 lb	2 lb 2 oz	10 Gal	16 lb 11 oz	6 lb	4 lb 3 oz	20 Gal	33 lb 6 oz	12 lb	8 lb 6 oz	40 Gal	66 lb 12 oz	23 lb 14 oz	16 lb 11 oz
5,000	12.8 oz	2.8 oz	1 oz	.61 oz	2 Qt	14 oz	4.8 oz	3.36 oz	2.5 Gal	4 lb 3 oz	1 lb 8 oz	1 lb 1 oz	5 Gal	8 lb 6 oz	3 lb	2 lb 2 oz	10 Gal	16 lb 11 oz	6 lb	4 lb 3 oz	20 Gal	33 lb 6 oz	11 lb 12.4 oz	8 lb 6 oz
2,000	5.12 oz	1.1 oz	.4 oz	.26 oz	25.6 oz	6 oz	1.92 oz	1.35 oz	1 Gal	1 lb 11 oz	9.6 oz	6.68 oz	2 Gal	3 lb 6 oz	11 lb 4 oz	13.5 oz	4 Gal	6 lb 11 oz	2 lb 62 oz	1 lb 11 oz	8 Gal	13 lb 6 oz	4 lb 12.4 oz	3 lb 6 oz
1,000	2.56 oz	.55 oz	.2 oz	.14 oz	12.8 oz	3 oz	.96 oz	.68 oz	2 Qt	13.6 oz	4.8 oz	3.34 oz	1 Gal	1 lb 11 oz	9.6 oz	6.72 oz	2 Gal	3 lb 6 oz	1 lb 3.1 oz	13.5 oz	4 Gal	6 lb 11 oz	2 lb 6.2 oz	1 lb 11 oz
500	1.28 oz	.28 oz	.1 oz		6.4 oz	1.4 oz	.48 oz	.34 oz	1 Qt	6.72 oz	2.4 oz	1.67 oz	2 Qt	13.5 oz	4.8 oz	3.36 oz	1 Gal	1 lb 11 oz	9.54 oz	6.72 oz	2 Gal	3 lb 6 oz	1 lb 3.1 oz	134 oz
200	.512 oz	.11 oz			2.56 oz	.56 oz	.2 oz	.14 oz	12.8 oz	2.68 oz	.96 oz	.68 oz	25.6 oz	5.4 oz	1.92 oz	1.35 oz	51.2 oz	10.7 oz	3.82 oz	2.67 oz	102.4 oz	1 lb 6 oz	7.64 oz	5.34 oz
100	.256 oz				1.28 oz	.28 oz	.1 oz	.64 oz	.64 oz	1.35 oz	.48 oz	.34 oz	12.8 oz	2.7 oz	.96 oz	.68 oz	25.6 oz	5.4 oz	1.91 oz	1.35 oz	51.2 oz	10.7 oz	3.82 oz	2.67 oz
50	.13 oz				.64 oz	.14 oz			3.2 oz	.68 oz	.24 oz	.17 oz	6.4 oz	1.4 oz	.48 oz	.34 oz	12.8 oz	2.72 oz	.96 oz	.68 oz	25.5 oz	5.4 oz	1.91 oz	1.34 oz
25	.064 oz				.32 oz				1.6 oz	.34 oz	.12 oz		3.2 oz	.68 oz	.24 oz	.17 oz	6.4 oz	1.36 oz	.48 oz	.34 oz	12.8 oz	2.72 oz	.96 oz	.67 oz
10	.026 oz				.128 oz				.64 oz	.14 oz			1.28 oz	.3 oz	.1 oz		2.56 oz	.56 oz	.192 oz	.14 oz	5.12 oz	1.12 oz	.384 oz	.27 oz
5	.013 oz				.064 oz				.32 oz				.64 oz	.14 oz			1.28 oz	.28 oz	.1 oz		2.56 oz	.56 oz	.192 oz	.14 oz

* Materials used are as follows: 5%—Sodium hyprochlorite (liquid) 25%—chlorinated lime (solid) 70%—calcium hypochlorite (solid) 100%—gaseous chlorine

hypochlorite should be used to disinfect the water in the tank trailer. The procedure for preparing and adding the solution to the tank trailer is as follows:

1. Fill the tank trailer half full of water.

2. Prepare a small amount of HTH concentrate by dissolving the required amount of HTH in a canteen cup or other container. In this case, place the 10 ounces of HTH in a l- or 2-gallon bucket of water.

3. Stir the mixture thoroughly. All of the granules will not dissolve. Allow undissolved granules to settle to the bottom of the bucket.

4. Add only the clear concentrate liquid to the tank trailer. By pouring the supematant into the tank trailer slowly, you can see that the settled granules will remain in the bucket.

5. Fill the remainder of the tank with the water to be treated

6. The water now must be agitated to distribute the HTH. In this example, you could simply attach the tank trailer to a vehicle and go for a short drive.

7. The final step is to take a FAC reading 30 minutes after adding the HTH. The reading must be at or above the required ppm. In this example, the FAC must read 100 ppm or higher. If the ppm is not high enough, add more HTH until the desired ppm is maintained.

NOTE

Remember that during superchlorination the FAC may not fall below 50 ppm wihin 4 hours or the whole procedure must be repeated.

After the 4-hour contact time and the tank trailer ppm has stayed above 50 ppm, the trailer is now disinfected. Rinse the tank thoroughly with potable water and then refill it for usage. An occasion may occur when you must use the water that you superchlorinated. If the chlorine ppm is too high, you may use sodium thiosulfate or sodium bisulfate to dechlorinate the water.

Table 2-3 shows water sources and the required chlorine residual.

For further information, see chapter 9 of the *Manual for Preventive Medicine,* NAVMEDP-50109.

Table 2-3.—Chlorine Residual Chart

WATER SOURCE	REQUIRED CHLORINE RESIDUAL
Public water supply system of questionable quality	5.0 ppm FAC after 30-minute contact time and maintain at a minimum of 2.0 ppm FAC throughout the distribution system
Engineering water points	5.0 ppm FAC at the standpipe or fill hose
Water tankers, trailers, bladders, and cans	Maintain between 5.0 ppm and 2.0 ppm FAC when filling from an approved water point. Maintain 5.0 ppm FAC when used as a source of distribution (piping system)
Distribution (piping) system	Maintain 5.0 ppm at the source and 2.0 ppm FAC at the spigot
Lyster bags and canteens	Maintain 2.0 ppm FAC when filling from an approved water source. Chlorinate to 5.0 ppm FAC initially and maintain at 2.0 ppm FAC when filling from an unapproved or raw water source

Diatomite Water Purification Unit (3000-D)

The 3000-D Water Purification System is portable and completely self-contained, as shown in figure 2-25. The unit purifies turbid and bacteria-polluted water. Particular attention was paid to design and packaging to increase efficiency, mobility, and cost effectiveness. It also provides a trouble-free method of producing potable water at the rate of 3,000 gallons per hour.

The system is constructed in separate modules, interconnected, and mounted in a common chassis. The chassis is not required for operation, but it greatly eases the transportability of the system. The system contains all of the functional apparatus and supplies necessary to process approximately 20,000 gallons of potable water. The user must have a water source and a

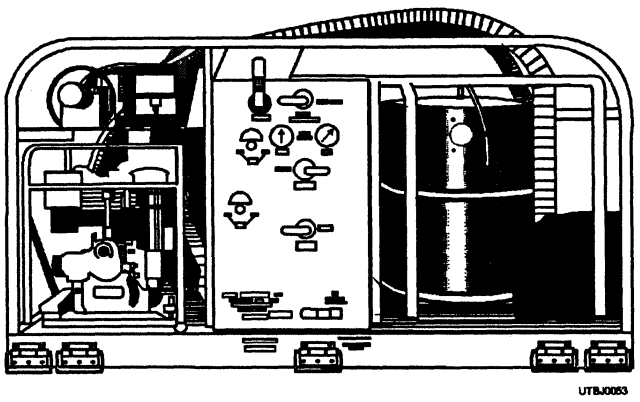

Figure 2-25.—3000-D water purification unit.

container to hold the processed water. Subsequent water processing requires only diatomaceous earth (DE), chlorine, and fuel.

The major components of the system are shown in figure 2-26. This mobile water purification unit contains a diesel-powered pumping module, a control and chlorination module, a filter module, supplies, and components mounted within a protective frame. It is supported on a pair of skids. Each module may be operated independently in or out of the frame because the interconnections and external connections use the same cam-locking devices. The unit may or may not be mounted on a trailer. The 3000-D can be set up and operated by one person, and it requires no support equipment.

The power for the system is supplied by an air-cooled diesel engine to take advantage of a greater fuel supply in the field.

A highly durable bronze pump, directly linked to the engine, provides both the suction to draw in the untreated water and to provide the water pressure to the unit. The 3000-D Water Purification System is designed to be transported to remote sites on its own optional trailer, on the back of a compact pickup truck, or air-lifted by helicopter with its own standard sling.

SETUP.-At the site, the system should be located on a level area located as close to the water source as possible to reduce suction lift to a minimum. For best results, the system should be located not more than 15 feet above the liquid supply. The suction line should be as short as possible and have few bends to keep friction losses low. The system is usually placed within 30 feet

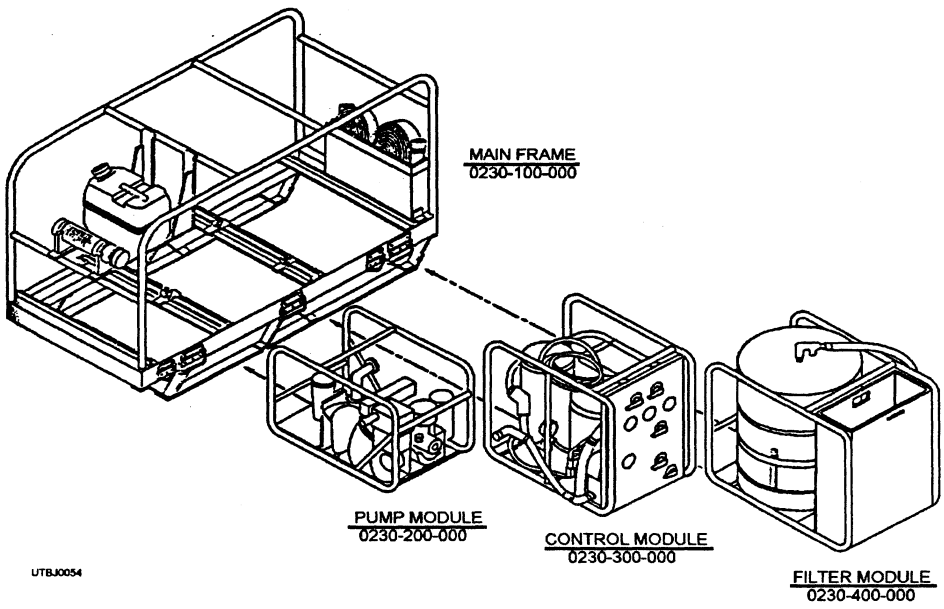

Figure 2-26.—Separate modules of the 3000-D unit.

of the water source. The semirigid suction hose segments are removed from the main frame mounting cam locks and fitted together with a suction strainer placed in the water source. The green freshwater hose is fitted to the freshwater discharge port on one end. The other end feeds the processed water to the potable water holding tank or dispersement center. One end of the blue wastewater hose is fitted to the wastewater discharge port. The other end is placed so runoff can take place without hampering or contaminating further operations.

START-UP.—Follow the steps listed below before starting the engine.

1. Fill the pump strainer with water to prime; close the cover tightly.

2. Set all control valves to START, as shown in figure 2-27.

3. Remove the DE storage container and set it aside.

4. Fill a 3-gallon bucket three-quarters full of water and add three 2000 ml measures of DE slowly, stirring the mixture as you add the DE. Do NOT add the DE to the DE tank at this time.

5. Fill a 3-gallon bucket three-quarters full of water and add 8 ounces of chlorine. After mixing the calcium hypochlorite solution, allow the solution to settle. When the mixture is settled, pour the solution into the hypochlorite tank.

The engine of the 3000-D is equipped with an automatic decompression device and an excess fuel-starting device that allows the engine to start easily and safely. The automatic decompression device has three positions:

1. Operation—the decompression is OFF, the engine has compression.

2. Neutral—for cold starting, compression is OFF.

3. Start position—cranking the engine causes the automatic decompression to operate. When the pin moves into the operating position, decompression ends and the engine fires.

WARNING

Never use the decompression device to stop the engine. This causes internal engine damage.

CAUTION

Wear hearing protection.

The procedures for a cold start are as follows:

1. Place the automatic decompression device in START and pull the excess fuel-starting device.

2. Insert the crank handle into the crank-handle guide. If you are not sure of the proper way to place your hand on the crank handle while cranking, then ask your supervisor for instructions.

3. Crank the engine slowly for four cranks and then turn the crank as quickly as you can. Once the engine starts, run the engine at half speed for about 1 minute.

4. Raise the engine to full speed.

Once you have precoated the filter, the unit is ready to perform the function of purifying water. Every 30 minutes, check the chlorine residual, the turbidity of the potable water, and the DE tank for slurry mixture.

Backwashing of the filter must be done when the pressure difference between the filter inlet and the outlet exceeds 20 psi.

SECURING THE UNIT.—Set the control valves as follows:

1. Outlet selector valves—WASTE

2. Waste outlet valve—OFF

3. Backwash valve—BACKWASH

4. Precoat valve—FILTER

5. Filter drain valve—DRAIN

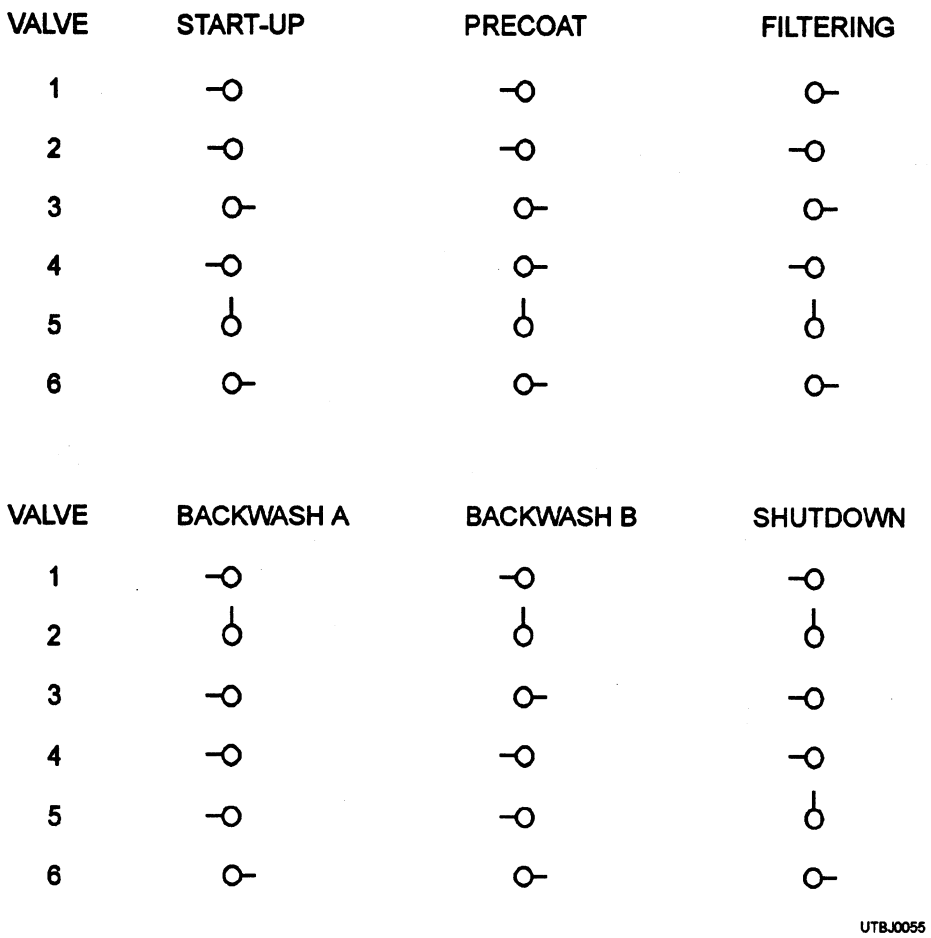

Figure 2-27.—Valve positions.

Let the engine idle for 5 minutes, and then place the speed- regulating lever to STOP until the engine stops. Pull the excess fuel-starting device, and place the speed-regulating lever to FULL LOAD.

Further information on operation, preventive maintenance, and troubleshooting of the 3000-D can be found in the *Technical Manual for the Model 3000-D (Diesel Powered) Modular, Field Portable Water Purification Unit, Goodman* Ball, Inc., 1989.

Reverse Osmosis Water Purification Unit (ROWPU)

Potable water is acritical element in the operational functioning of the Seabees. The 600 GPH Reverse Osmosis Water Purification Unit (ROWPU) purifies water by reducing the dissolved and suspended solids in water. The unit processes raw water, brackish water, and seawater into potable water. Additionally, the ROWPU can treat water contaminated with CBR agents. Two views of the 600 GPH ROWPU can be seen in figure 2-28.

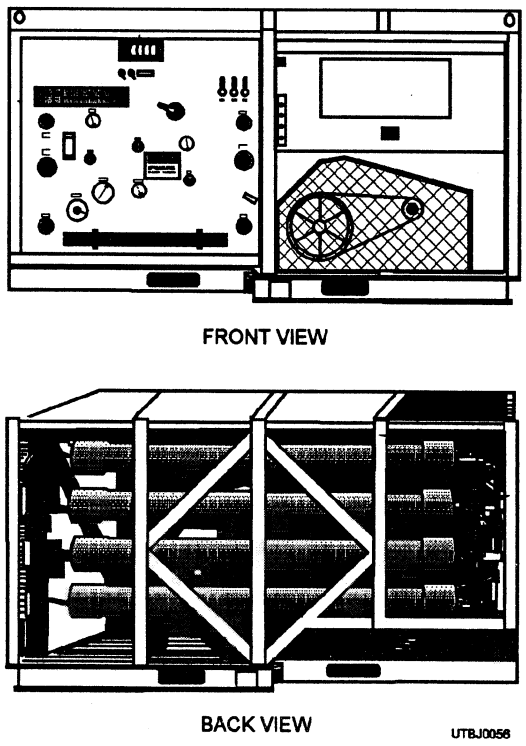

Figure 2-28.—Two views of the 600 gph ROWPU unit

The purification is done by filtering the water to remove the majority of suspended solids. Once the majority of the suspended solids are removed, high pressure forces the water through a semipermeable membrane. A maximum of 600 pounds psi is used for fresh and brackish water, and a maximum of 900 pounds psi is used for salt water. Chemicals are added to the product water to kill bacteria.

SUPPORT EQUIPMENT.—The self-contained skid-mounted ROWPU unit requires a portable generator capable of providing 30 kilowatts of power (fig. 2-29).

Other supportable equipment includes the following: portable onion skin bladders (3,000 gallons), as shown in figure 2-30, or collapsible water tanks (3,000 gallons); four frame-mounted, portable, electrical motor-driven water pumps with hoses and fittings; water test equipment (TDS meter, color comparator, etc.); and an operating supply of chemicals (chlorine, sodium hex, polymer, and citric acid).

WATERFLOW THROUGH THE ROWPU.—you read through the next 18 items listed, refer to the flow diagram in figure 2-31.

1. This is the water source that you are going to purify through the ROWPU.

2. The strainer is attached to the end of the intake hose to keep rocks, leaves, and any other foreign objects from entering the pumps and filters.

3. The first of the two pumps that draw water from the water source and pump the water to the ROWPU.

4. The second of the two pumps that draw water from the water source and punp the water to the ROWPU.

5. The polymer pump adds a polyelectrolyte solution to the raw water. The polymer causes coagulation of small floating particles. This enables the filters to remove the particles.

6. The sodium hex pump adds a solutionof sodium hexametaphosphate to prevent scaling of the filters.

7. The multimedia filter is the first actual filter that the raw water goes through.

8. After the water has been filtered, the booster pump draws the water and forces it through the cartridge filter.

9. As the water goes through the cartridge filter, tiny particles that were not filtered out by the multimedia filter are filtered out.

10. The reverse osmosis (RO) pump increases the filtered water pressure and forces the water through the RO elements (semipermeable membranes)

11. The pulse dampener is simply a ball-shaped device that reduces the shock caused by the piston action of the pump.

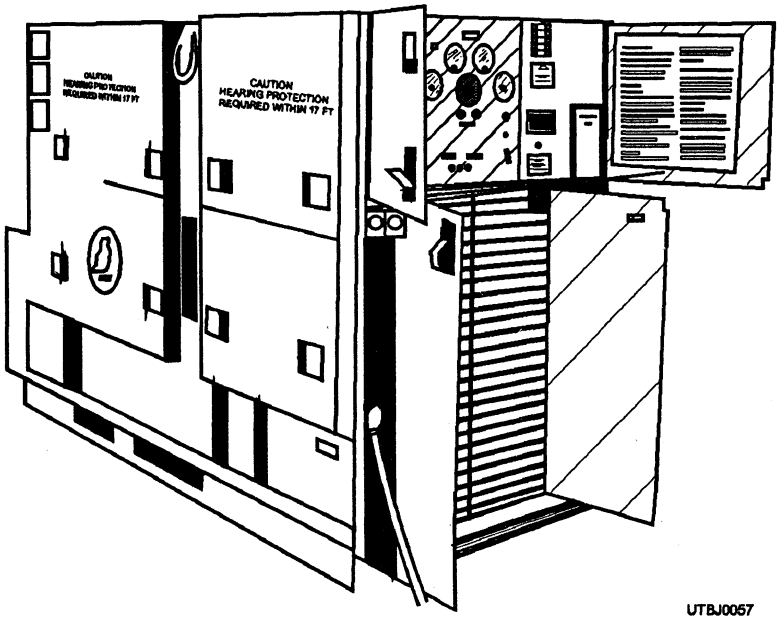

Figure 2-29.—Generator skid-mounted.

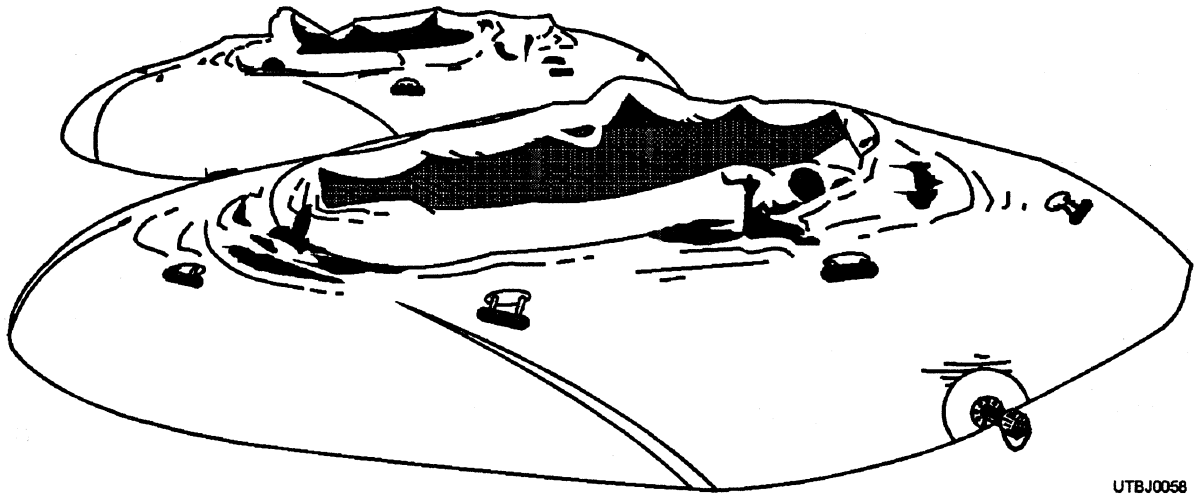

Figure 2-30.—Portable onion skin bladders, 3,000 gallon.

12. All of the dissolved solids are removed from the water in the membranes. The membranes consist of rolls of thin film that separate dissolved solids from the water.

13. Once the water comes out of the RO elements, the chlorine pump injects chlorine into the product water to kill bacteria that is present. If the chlorine pump is not in use, you must batch chlorinate the water in the bladder or storage container.

14. The product water tank is a storage device for holding product water (potable water). The tank may be a bladder, a container, or a collapsible tank.

15. The distribution pump is used to move the product water from the product-water tank into vehicles, tank trailers, and so forth.

16. A distribution nozzle is used to fill the end-users container.

17. Diluted citric acid cleans the RO elements. The citric acid lowers the pH of the water and improves the salt rejection of the elements.

18. A separate storage tank is used for the brine water. The brine is used to flush the multimedia filter. The backwash pump (19) forces the brine backwards (from bottom to top) through the filter media to flush out any unwanted accumulation in the filter.

19. The backwash pump provides pressure that pumps the brine through the multimedia filter for backwashing.

The ROWPU can purify 13.5 gallons per minute of product water from a fresh or brackish water source and 12 gallons per minute of potable water from a seawater source.

Temperature has a substantial effect on the quantity of product water the ROWPU can produce. The higher the temperature of the raw water, the more product water the ROWPU can produce. At 77°F the ROWPU can produce 600 gph from fresh or brackish water and 400 gph from seawater. Again, as the temperature of the water increases so does the flow of product water.

You can obtain more information about the ROWPU operation, setup, maintenance, and troubleshooting in the TM 5-4610-215-24, *Water Purification Unit, Reverse Osmosis 600 GPH Trailer Mounted.* Additionally, every NMCB is required to have eight UTs. This is accomplished by sending them to the SCBT 740.2, Water Treatment II course.

Q1. What is the primary responsibility of the Seabees?

Q2. What is the first procedure you should perform after receiving an ABFC assembly?

Q3. Where should the portable bath unit suction hose be located in relation to the wastewater drain?

Q4. Type I portable space heaters can be operated with what two types of fuel?

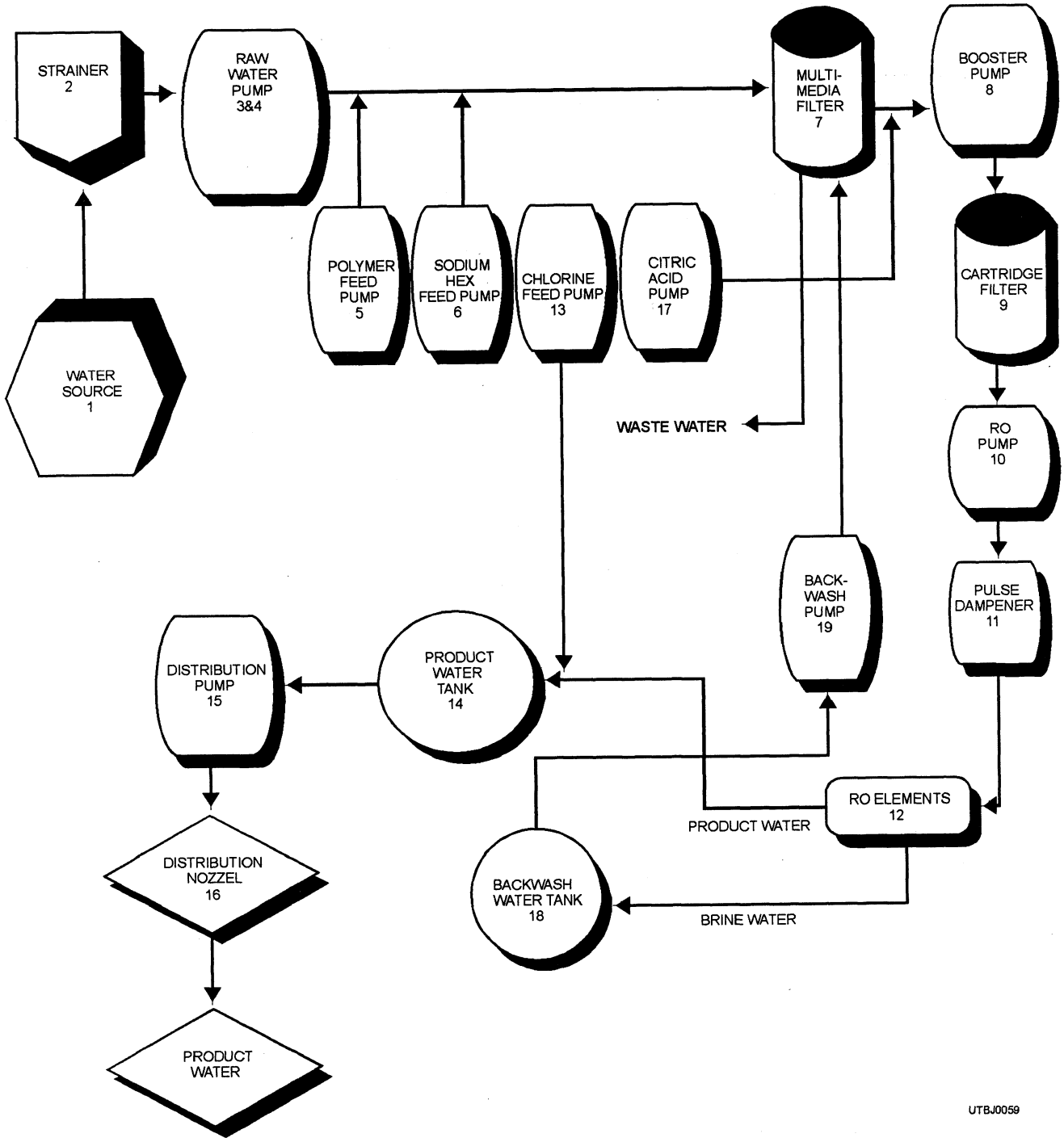

Figure 2-31.—Water flow through the ROWPU.

Q5. The stack of an immersion heater is divided into two sections. What are they?

Q6. Where are the operating instructions on an immersion heater located?

Q7. When the field range burner unit is used for frying, the burner should be placed in what position?

Q8. The number and size of cesspools depends on what two factors?

Q9. When a septic tank is being constructed, the length should be at least how many times larger than the width?

Q10. For a tile field in soil composed of clay and gravel, you should dig a trench of what minimum width?

Q11. An eight-seat field-type latrine can be expanded to how many additional seats?

Q12. What control runs the wash, the rinse, and the spin cycle of a skid-mounted laundry unit washer?

Q13. A lyster bag is primarily used for dispensing what types of water?

Q14. The 3000-D diatomite waterpurification unit should be locatedd what distance above the water supply?

Q15. What water purification unit purifies water by reducing dissolved and suspended solids?